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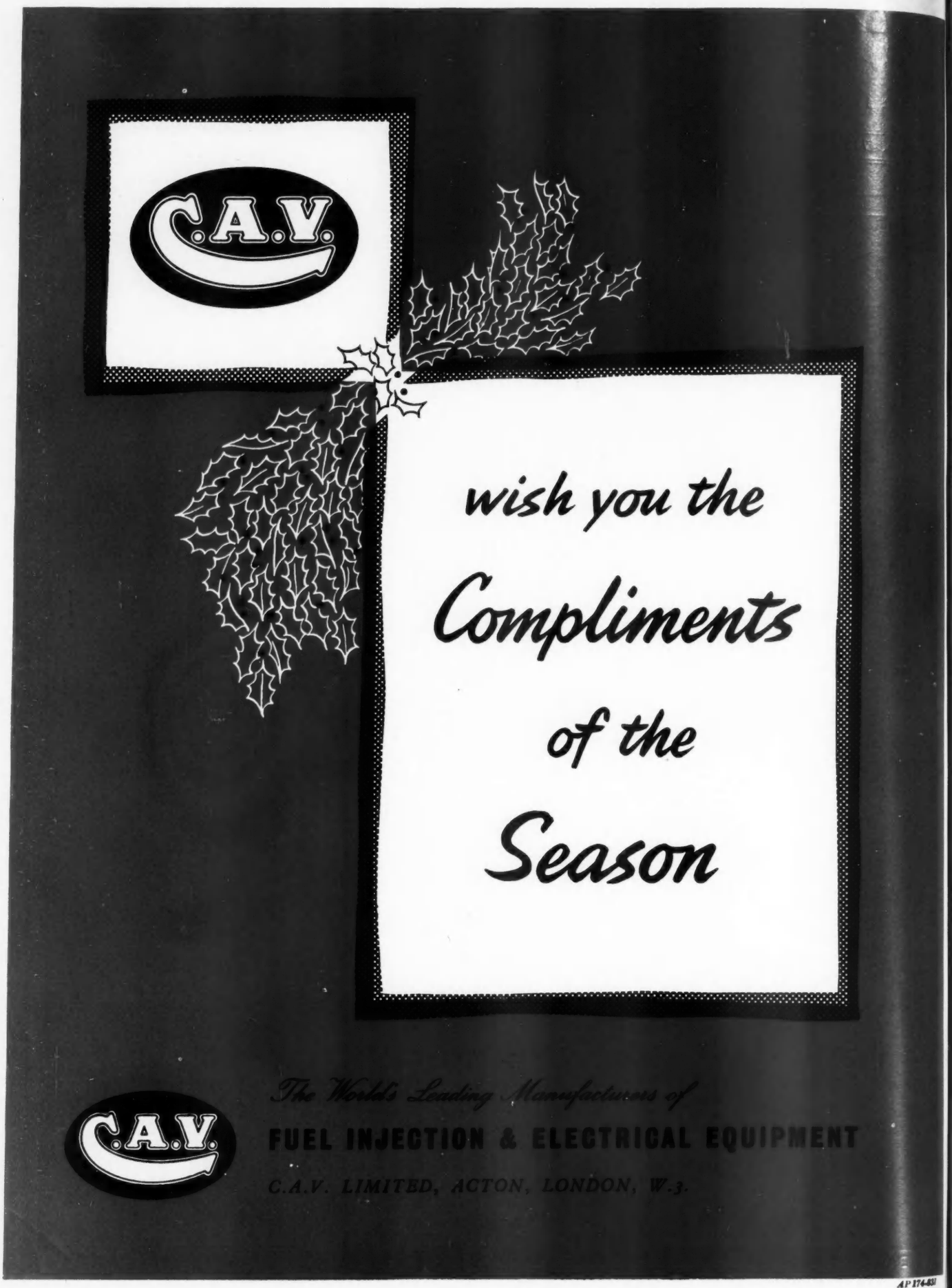
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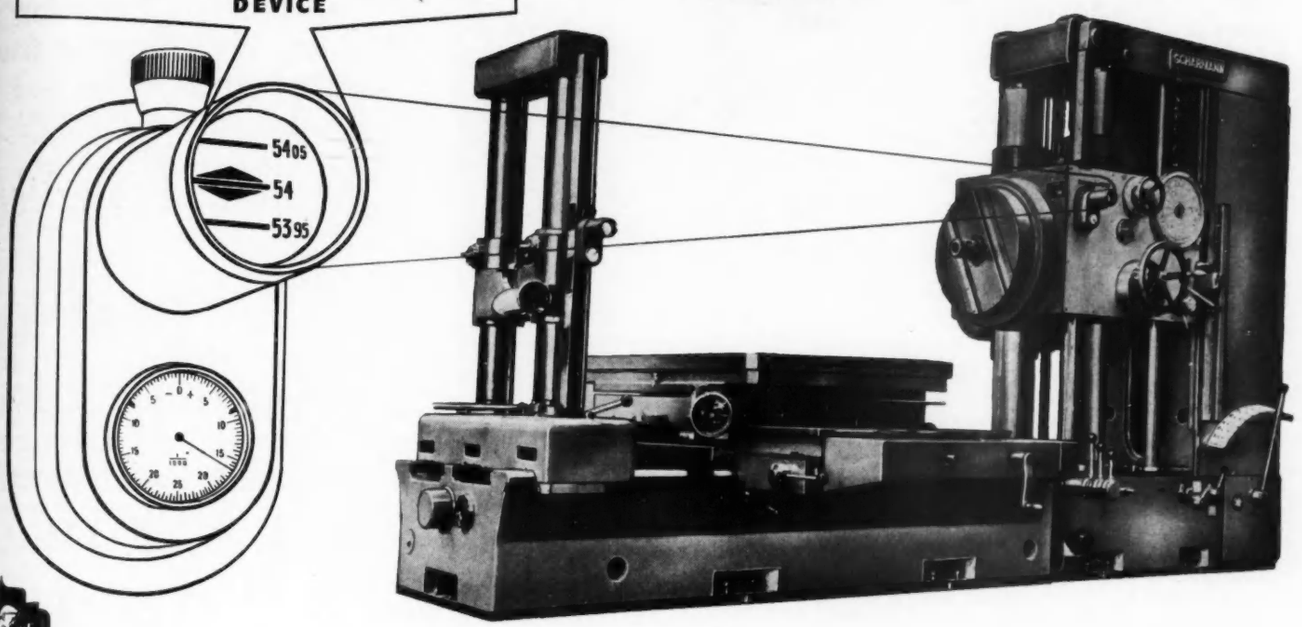

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ENGINEERING

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AN OPPORTUNITY WASTED

THE Electricity Bill—for reorganising the nationalised electricity supply industry—is a disappointing document. Nearly a year has elapsed since the Herbert Committee submitted the findings of their inquiry into the industry, together with their recommendations. The latter were based on five main conclusions reached after over a year's investigation of the working of an industry which they described as "not in any reasonable sense of the term an inefficient industry." The Herbert Committee found that:

(1) The formal structure of the industry was not conducive to the highest efficiency. They recommended changes in the structural pattern involving the creation of a new Generation Board, Distribution or Area Boards with a greater degree of autonomy than at present, and a new Central Authority whose main functions would be to approve the plans of the Generation Board and of the Area Boards and to exercise certain clearly defined supervisory functions. "We are satisfied," they said, "that there is a real and valuable job to be done within the industry by an independent supervisory body."

(2) The industry had not solved the problem of the right degree of delegation within the formal framework, "partly, no doubt, as the result of anxiety over public accountability." Subordinate officials must be allowed to make mistakes, "as part of the price of delegation that large-scale organisations must pay if they are to remain virile."

(3) The industry lagged behind in the introduction of modern aids to good management, in budgeting, in work study, in operational research, in incentive wages systems and the like.

(4) The industry must take very energetic steps to ensure that it attracts and retains an adequate supply of first-rate talent for both technical and managerial posts. Substantial increases in salaries were recommended.

(5) The industry had not done as much hard thinking as it should about the economics of electricity supply. In future, it should be run strictly on business lines.

The Government have not accepted the first, basic, recommendation. The Bill proposes that there should be no Central Authority for policy making, but an Electricity Council instead. In the White Paper accompanying the Bill it is argued that a new Central Authority would have "greater power over the industry with little corresponding responsibility," which, in the Government's view, "would operate against the development within the individual Boards of that sense of initiative and responsibility which the Herbert Committee considered essential to the health of the industry." Instead they propose an Electricity Council, with one chairman and one or two deputy chairmen appointed directly by the Minister. In addition, the Council will comprise the chairman and one other representative of the Generating Board, and the 12 chairmen of the Area Boards. The Council's function will be "to promote and assist" the efficient operation of the industry. Practically all the policy functions of the Central Authority are taken over by the Minister. He will be responsible for approving each Board's capital plans, the industry's research programme and borrowing requirements of the Generating Board. The Area Boards will not be empowered to borrow on the market as the Herbert Committee recommend they should be. The chairman of the Council "will advise" the Minister on questions of policy. Does this mean that the reconstituted structure will have no head other than the Minister of Fuel and Power? Will he also, in time, head the National Coal Board and the Gas Council? Far from giving the industry a better opportunity of operating as a commercial concern, the Bill transforms the industry into an adjunct of Whitehall.

The anxiety over public accountability can only grow more, and the delegation problem get worse. There is no mention in the Bill or the White Paper of management aids to efficiency; but—much more serious—no provision is made for an increase in the salaries of top executive officers. Yet for some years now the C.E.A. have found it exceedingly difficult to keep their best electrical engineers, for the simple reason that they do not pay salaries competitive with private industry.

The Bill has yet to be debated, and it may be that many in both Houses and from both parties will expose its many faults. Should it become an Act in its present form, it may prove exceedingly hard to fill the top jobs with first-rate men. Excessive political supervision of nationalised industries has proved singularly unattractive in the past. A really good man wants to be master of his own concern, or answerable to someone who is. The opportunity open to the Government of establishing a first-class structure for the industry, giving it every chance of commercial success, has been wasted. The Herbert Committee believed that the less the principle of commercial operation is invaded the better it will be for the efficiency of the industry. They conceived the Minister's principal function to be that of the appointment of Authority and Board members. For the rest, "if prices are to be related to costs and the industry is to go to the market for its capital in competition with other indus-

tries, the Minister will be involved in few policy questions . . . The further our conception is departed from, the more policy questions will the Minister have to decide." Should the Bill go through, the Minister will spend all his time deciding policy questions, and looking for Board members.

* * *

Plain Words

After a short and disappointing debate last week, the House of Commons agreed a Government motion to set up a select committee to "examine the reports and accounts of nationalised industries." The Opposition tabled an amendment, but disagreement was more on means than on objects. They are considering privately the possibility of some sort of efficiency audit team "which would roam over the whole field of the nationalised industries," as an alternative to committees of the Fleck or Herbert committee type. Both parties are equally determined to have the nationalised Board's affairs discussed in Parliament. The risk that this might degenerate into systematic and thoroughly disruptive interference is much greater than the debate suggested. Some Conservatives dislike the idea of nationalisation so much that they can be expected to indulge in the "muck raking" feared by the Opposition. Some Labour members are so partial to political control that they can hardly be expected to preserve the independence of enterprises which, according to Mr. Butler, "are and must remain fundamentally commercial in character."

Is political control of commercial organisations desirable, or practicable? There is certainly a legitimate concern with the amount of public money which is spent, but this is done also by private industry—in aircraft manufacture, agriculture and others when research and development work is heavily subsidised. It is difficult to conceive what a select committee with loose terms of reference would do. Perhaps they would act as experts on organisation and methods as the Fleck and Herbert committees have attempted to do. Or they would be there to prevent fraud by vetting the accounts—surely the job of properly qualified auditors.

There is the unmistakable feeling that the debate was about the means of getting politicians further inside industry's affairs. It was left to a Labour M.P., Mr. Ronald Williams, to say that the committee could become "so fierce" in focussing and scrutinising that the leaders of nationalised industries "would become more conscious of that scrutiny than of doing their own job." It will not do to say, as Mr. Butler did, that the whole purpose of the new committee was gradually to create in the House "a body of informed opinion about these industries." Already the Ministry concerned and his parliamentary *aides* have that, or should have. Similarly, their opposite numbers in the shadow Cabinet can contribute informed opinion. One is left with the feeling that these moves are prompted by political motives, not by considerations of State.

SCALE MODELS FOR FACTORY LAYOUTS

THE THIRD DIMENSION IN PLANNING

By John V. Spenlove Brown, A.M.I.MECH.E.

With the ever-increasing complexity of modern production techniques—coupled with the need to utilise every square foot of floor area—the problems of factory planning have become very intricate. The use of materials-handling equipment, both in the form of conveyors and in the transport and storage of components by truck and pallet, has emphasised the importance of the vertical component in planning and there must have been many layout engineers who have wished they could have the factory in miniature spread out before them so that all its inter-related parts could be seen as a single picture. There are few layouts where the "third dimension" can be disregarded because, even in a jobbing shop, the machines are not entirely unrelated and there is often the limitation of the clearance required for an overhead crane. When machines work in a line or group, however, and function at such a rate that the products must be transported in a plane above the floor or from one floor level to another, the established method of planning with the help of flat drawings or cardboard cut-outs has its limitations.

Some concerns have long had a policy of using block models as an aid to planning, and of employing apprentice labour to fashion them, together with the necessary surroundings of baseboard, stanchions, walls, partitioning, etc., but these facilities are not always available and the need for a more realistic type of model, produced at an economic price, has been felt.

It is in an effort to meet these two factors that the firm of Visual Planning Systems, Limited, Athlon-road, Alperton, Middlesex, has been working for a number of years. A wide range of the best-known machine tools has been reproduced in miniature from drawings supplied by the original makers; foundry patterns have been made and the pieces cast in aluminium alloy to form strong and durable models for factory use. In this way sufficient production can be achieved to put the models on a commercial basis and to maintain delivery at a rate that will keep pace with the development of the project itself.

COLOUR CODES

A model of a new machine shop at the Longbridge works of the Austin Motor Company is shown in Fig. 1. The interest in this particular layout lies in the care with which both the machine tools (including transfer and unit machines) and the conveyors have been modelled and in the amount of significant detail incorporated. Considerable use is made of colour—pale green for machines, silver for heat-treatment plant, red for conveyors, yellow for trucks and a complete code for services is represented by coloured cellulose tape. All the items were made and the model assembled in five weeks by dividing the work between the layout engineers of the Austin company and the modelling firm. The gridded baseboards, stanchions and partitioning, together with all the machine tools, were made by the latter while the Austin engineers prepared the wide variety of handling devices employed in the project. As planning discussions were being held round the model while it was under construction it was soon fulfilling its function. Indeed, the company report that the time saved in the planning of one particular section was most marked. In a single morning a dozen different layouts were tried and rejected before a solution was agreed upon, whereas weeks would have been required to draw out and circulate each proposal.

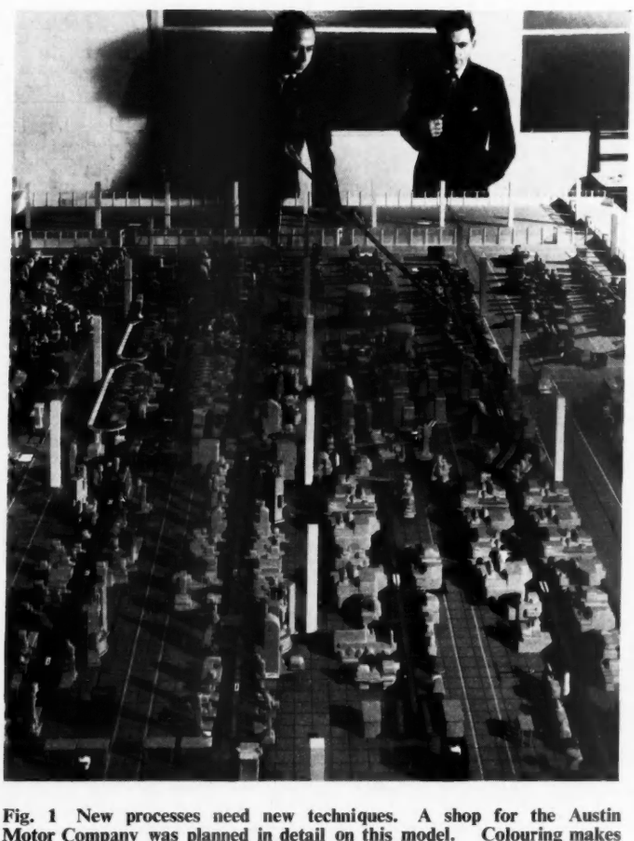


Fig. 1 New processes need new techniques. A shop for the Austin Motor Company was planned in detail on this model. Colouring makes schemes easy to put over to all grades of staff.

Sometimes the problems are such that it is necessary to represent the buildings as accurately as the machines and Fig. 2 shows such a layout for one of the factories of William Asquith, Limited, at Halifax. This firm's premises have grown with the years and are now needed to accommodate new machinery. The model will help this to be done with the minimum disruption of production and will also permit the planning of movements within the works of the large machine tools and components made by the company. In this project, standard cast-aluminium miniatures are augmented by specially fabricated models representing large items such as planing machines, etc., and Perspex

Fig. 2 The planning model for one of the factories of William Asquith, Limited, Halifax. The building, including changes in floor level and the overhead cranes, as well as the machines, are accurately represented.

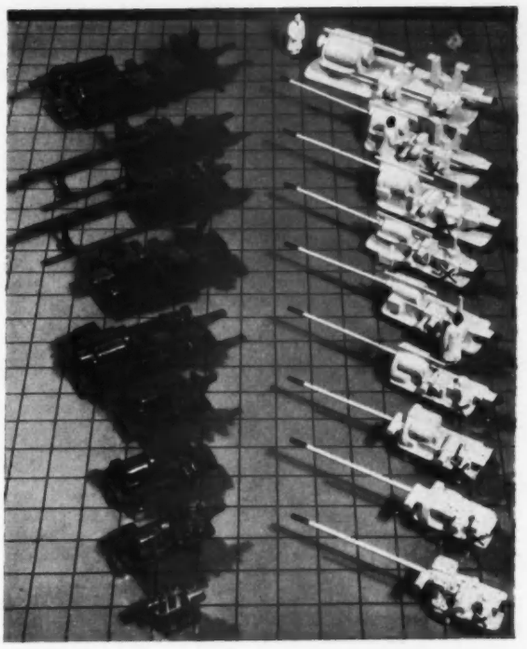


Fig. 3 The patterns of a series of Herbert capstan lathes are on the left; on the right are finished models of the Ward range. The planning board is marked in 1 yard squares to the same scale.

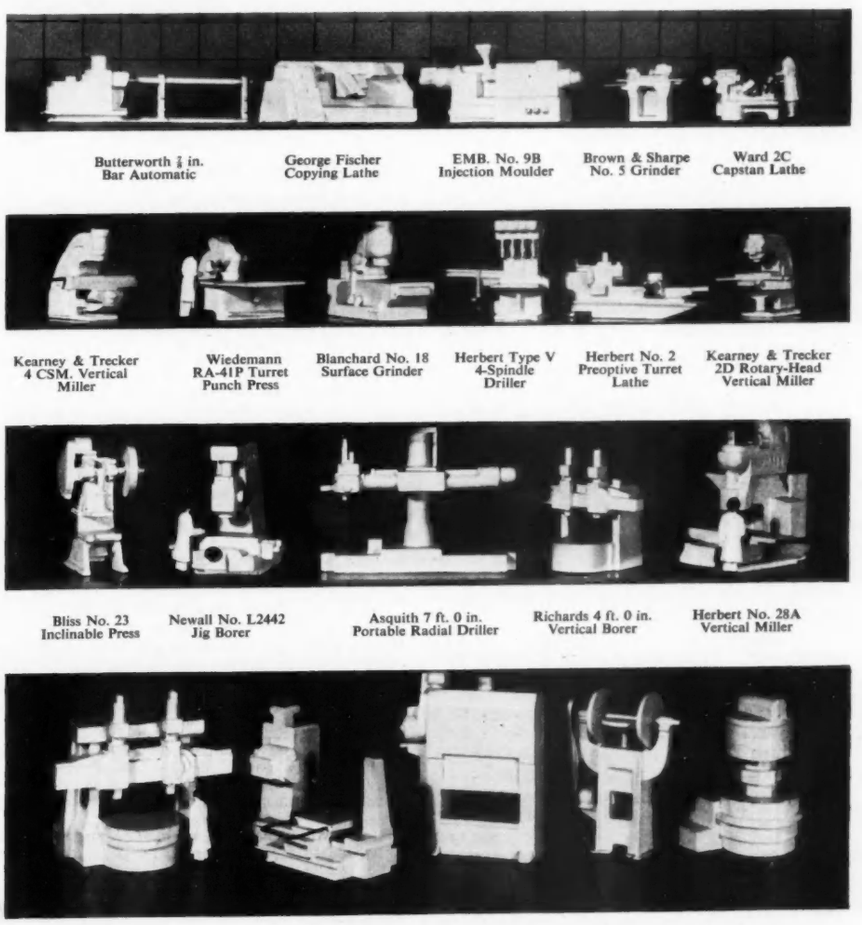
has been employed in the construction of floors and partitioning. The differences in floor levels on the sloping site are shown on the model, and all doorways and cranes are modelled to scale so that clearances can be directly measured.

In manufacturing models for planning there is something of an art in selecting the detail to be represented, but accuracy of overall dimensions must always be ensured; all movements and traverses must be indicated and sufficient of the characteristic shape included to show the scale and make the machine readily recognisable. The tendency is for this detail to increase as machines become more complex. For instance, control cabinets and splash guards are now normally built-in and therefore the models must reflect the increased areas of the prototypes. Fig. 3 shows two well-known ranges of capstan lathes which display these features and Fig. 4 is a group of recent additions to the models available from stock patterns. The cost of this type of equipment may be judged from the fact that the pieces shown average about 10*s*. each.

MODEL SIZE

Light and medium machine shops were the first field of usefulness for commercially-made models but recent applications have extended to such diverse activities as heavy engineering (including steam turbines and the rolling of titanium), chemical manufacture, office planning, textile machinery, food processing, apprentice training and many branches of the electrical and motor industries. Fig. 5 is a photograph of a model used for the re-organisation of a textile factory.

The choice of a suitable scale has been given much thought. The size adopted must always be a compromise between the detail which can be incorporated in the individual model and the space to be occupied by the complete layout. The scales usually considered are $\frac{3}{8}$ in. to 1 ft. (1 : 32) and $\frac{1}{4}$ in. to 1 ft. (1 : 48). The $\frac{1}{4}$ in. scale is widely used in the United States, where the areas to be planned can be very great, but the $\frac{3}{8}$ in. scale is the one most called for in this country. There is nothing to choose between them on the score of price—in fact, the smaller models tend to be more exacting in manufacture and therefore more expensive—but in Britain the $\frac{3}{8}$ in. scale has the advantage of the large range of patterns already in existence. If it is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Newall No. L2442 Jig Borer
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Herbert No. 28A Vertical Miller
Richards 6 ft. 0 in. Vertical Borer
Kearns No. 2 Wide-bed Horizontal Borer
Craig & Donald SG. 6-72 Press
Hordern, Mason & Edwards 160 ton Friction Screw Press
Bullard 12 in. Vertical Automatic

Fig. 4 Typical aluminium-cast models, showing the wide range that is available.

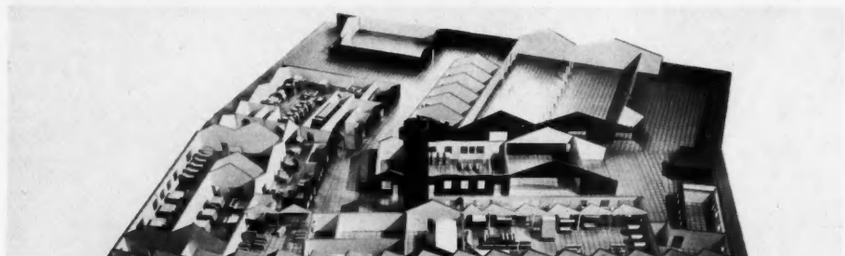

Fig.5 Planning model used in the re-organisation of a textile factory. The machines and the buildings are accurately portrayed, showing that the machines could be laid out with adequate working space between the close-spaced stanchions of the old building.

considered that the scale to be employed for any particular project should be the largest which can be easily accommodated, $\frac{3}{8}$ in. seems to fulfil the conditions most frequently met.

In conclusion, the value of three-dimensional planning equipment can be summed up:—

(1) It stimulates the imagination in planning and reduces inaccuracies in the placing of the machines.

(2) It enables vital dimensions, including height and overhead clearances, to be directly measured.

(3) Explanations are reduced and confusion avoided because the projected scheme can be quickly understood by shop-floor workers, supervisors and management alike.

(4) Colour can be used to enhance the realism of the layout. Colour coding is also a valuable medium for indicating phase development or the sources of materials or equipment.

Letters to the Editor

CRITERIA OF YIELD

SIR, As is well known, practically every paper dealing with plasticity or with the effect of combined stresses involves frequent reference to the von Mises-Hencky hypothesis, the von Mises-Hencky equivalent stress, and other similar terms. Occasionally the name of Huber is prefixed i.e., the Huber-von Mises-Hencky hypothesis. The references are to papers written by the authors mentioned in 1904, 1913 and 1924 respectively; the comparative neglect of Huber's name is probably due to the fact that his paper was printed only in Polish. This clumsy double or triple nomenclature can be avoided to some extent by referring to the hypothesis as that of critical shear-strain energy, or distortion energy, or to the stress as an octahedral stress (multiplied by a constant). There are, however, serious objections to these names, not only because they are frequently inappropriate (e.g., when plastic deformation has occurred, the criterion is no longer straightforwardly that of critical shear-strain energy) but also because they carry physical implications which may be unwarranted.

The present seems an appropriate time to point out that there is a case for attributing the hypothesis to its first enunciator (or at least to one who enunciated it nearly 50 years before Huber), namely James Clerk Maxwell. It is a 100 years ago this month that Maxwell wrote to William Thomson (later Lord Kelvin) a letter[1] of which an extract follows:—

129 Union Street (Aberdeen).
18 Dec., 1856.

. . . In connection with this, see your brother's papers on strained wires after the stress has been removed.

Here is my present notion about plasticitiy of homogeneous amorphous solids.

Let $\alpha\,\beta\,\gamma$ be the 3 principal strains at any point; P Q R the principal stresses connected with $\alpha\,\beta\,\gamma$ by symmetrical linear equations the same for all axes. Then the whole work done by P Q R in developing $\alpha\,\beta\,\gamma$ may be written

$$U = A(\alpha^2 + \beta^2 + \gamma^2) + B(\beta\gamma + \gamma\alpha + \alpha\beta)$$

where A and B are coeffts, the nature of which is foreign to our inquiry. Now we may put

$$U = U_1 + U_2$$

where U_1 is due to a symmetrical compression ($\alpha_1 = \beta_1 = \gamma_1$) and U_2 to distortion without compression ($\alpha_2 + \beta_2 + \gamma_2 = 0$) and

$$\alpha = \alpha_1 + \alpha_2, \quad \beta = \beta_1 + \beta_2, \quad \gamma = \gamma_1 + \gamma_2.$$

It follows that

$$U_1 = \frac{1}{3}(A + B)(\alpha + \beta + \gamma)^2$$

$$U_2 = \frac{2A - B}{3}(\alpha^2 + \beta^2 + \gamma^2 - (\beta\gamma + \gamma\alpha + \alpha\beta)).$$

Now my *opinion* is, that these two parts may be considered as independent, U_1 being the work done in condensation and U_2 that done in distortion. Now I would use the old word "Resilience" to denote the work necessary to be done on a body to overcome its elastic forces.

The cubical resilience R is a measure of the work necessary to be expended in compression in order to increase the density permanently. This *must* increase rapidly as the body is condensed, whether it be wood or lead or iron.

The resilience of rigidity R_2 (which is the converse of plasticity) is the work required to be expended in pure distortion in order to produce a permanent change of form in the element. I have strong reasons for believing that when

$$\alpha^2 + \beta^2 + \gamma^2 - \beta\gamma - \gamma\alpha - \alpha\beta$$

reaches a certain limit $= R_2$ then the element will begin to give way. If the body be tough the disfigurement will go on till this function U_2 (which truly represents the work which the element *would do* in recovering its form) has diminished to R by an alteration of the *permanent dimensions*.

Now let $a\,b\,c$ be the *very small* permanent alterations due to the fact that $U_2 > R_2$ for an instant. Whenever $U_2 = R_2$ the element has as much work done to it as it can bear. Any more work done to the element will be consumed in permanent alterations.

Therefore if $U_2 = R_2$, and in the next instant, U be increased, dU must be lost in some way.

My rough notion on this subject is that

$$a = \frac{dU}{U}\alpha, \quad b = \frac{dU}{U}\beta, \quad c = \frac{dU}{U}\gamma$$

the new values of $\alpha\,\beta\,\gamma$ will be

$$\alpha' = \alpha - a, \quad \beta' = \beta - b, \quad \gamma' = \gamma - c.$$

This is the first time that I have put pen to paper on this subject. I have never seen any investigation of the question, "Given the mechanical strain in 3 directions on an element, when will it give way?" I think this notion will bear working out into a mathematical theory of plasticity when I have time; to be compared with experiment when I know the right experiments to make.

Condition of not yielding

$$\alpha^2 + \beta^2 + \gamma^2 - \beta\gamma - \gamma\alpha - \alpha\beta < R_2.$$

At this time, Maxwell was 25 years of age and in his second month in the chair of Natural Philosophy at Aberdeen. There is no further reference to plasticity in the book, nor is there any reference to the subject in the *Collected Works*. It is greatly to be regretted that Maxwell did not in fact find time in his too short life to return to the subject.

Even recent writers on the theory of plasticity or on the history of strength of materials have generally made only passing reference, if any, to this statement by Maxwell, presumably owing to its inaccessibility until published in 1937. Exceptions are van Iterson[2] and Timoshenko.[3] It will be seen that Maxwell's statement of the hypothesis is in exactly the same form as is now generally used, with the exception that he used strains instead of stresses.

It would be a graceful tribute to the memory of a great scientist in a field with which he is not generally associated, as well as a matter of practical convenience, if the criterion and hypothesis could be referred to in future as Maxwell's.

Yours faithfully,

D. G. SOPWITH,
Director, Mechanical Engineering Research Laboratory, East Kilbride.

J. L. M. MORRISON,
Professor of Engineering, University of Bristol.

November 27, 1956.

[1] *Origins of Clerk Maxwell's Electric Ideas* (*Letters to W. Thomson*), by Sir Joseph Larmor, Cambridge University Press, pages 32-33 (1937).

[2] *Plasticity in Engineering*, by F. K. van Iterson, Blackie & Son, Ltd., page 68 (1947).

[3] *History of Strength of Materials*, by S. Timoshenko, McGraw-Hill, pages 368-9 (1953).

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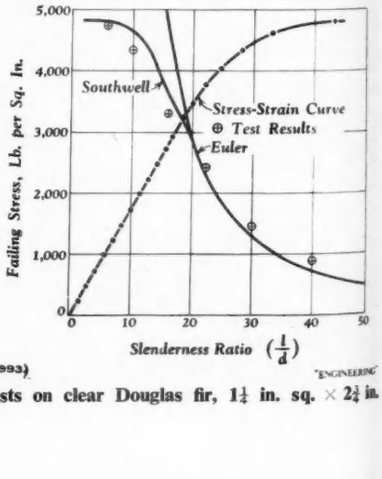
ELASTIC STABILITY UNDER COMBINED LOADING

SIR, I have read with interest the article "Elastic Stability under Combined Loading," by Mr. A. N. Procter, published in ENGINEERING on November 23 (page 655), and I note that it is proved mathematically that the buckling strength of a long column with ends fully restrained is about three times greater than it would be with "ends free" or "rounded," two diagrams of test data and Eaton Hodgkinson's opinion being given in support. The British Standard Codes of Practice CP113 and CP114 require the effective length of columns "properly restrained at both ends in position and direction" to be 0·7 *l* and



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Tests on clear Douglas fir, 1½ in. sq. × 2½ in.

0·75 l respectively, thus allowing working loads for long columns to be about twice the loadings permitted with ends " properly restrained at both ends in position but not in direction ", whereas the Euler theory suggests that the ratio of the strength of " ends fixed " to " ends free " is four. Since this is a matter of fundamental importance, affecting the economics of the design of light structures, it would be of interest to know what other coroborative evidence is available.

It is usually considered that the Euler limit of ductile materials is at or about the yield point of the material in compression and for other materials it is the proportional limit in compression. Tests on timber struts, published recently (Special Report No. 9, *The Strength of Timber Struts*, Forest Products Research Laboratory, D.S.I.R., published by H.M.S.O., 1955) indicate that the Euler limit of timber struts may occur at average axial stresses lower than the proportional limit, as shown in the accompanying diagram (Fig. 1 of the above report). That this discrepancy between theory and fact is related to the elastic properties and transverse distortion of the material is a matter that requires some further explanation.

The method of deriving the coefficient of axial force and in the second column of page 656 is clearly understood, but the alternative method of deriving the coefficient of lateral bending β, while giving the correct result, appears to have been incorrectly stated (see the Editor's note, below). The formula derived by Dr. E. H. Salmon for the deflection of a column with " ends free " carrying also a lateral load at mid-length (*Materials and Structures*, vol. 1, page 233) is, in the author's notation:—

$$y_o = \frac{W_Y l^3}{48\,E\,I_Y}\left(\frac{P_Y}{P_Y - F_A}\right).$$

Since P_Y is assumed to be $\frac{\pi^2 E I_Y}{l^2}$

$$\frac{l^2}{E\,I_Y} = \frac{\pi^2}{P_Y}$$

and since $M_{Yy} = \frac{W_Y l}{4}$

$$W_Y l = 4\,M_{Yy}$$

so that, by substitution, it is clear that

$$y_o = \frac{4\,\pi^2\,M_{Yy}}{48\,P_Y}\left(\frac{P_Y}{P_Y - F_A}\right) = \frac{0{\cdot}82\,M_{Yy}}{(P_Y - F_A)}.$$

Later, in the same column, it appears that the work done by a transverse bending moment that increases uniformly from zero at the supports to a maximum at mid-span should be:—

$$0{\cdot}35\left(\frac{\pi^2\,M_{Xx}\,\theta_o\,y_o}{2\,l}\right).$$

Yours faithfully,
T. EDWIN LEIVERS.

6 Sutton-road,
Kirkby-in-Ashfield,
Nottinghamshire.
November 27, 1956.

[*Editor's Note*:—The second part of Mr. Leivers' letter draws attention to and corrects some errors, not in the author's manuscript, in the mathematical argument leading to the expression for the coefficient of bending, β, which was, as Mr. Leivers points out, correctly given. The final remark of the letter, referring to work done by a transverse bending moment, relates to the printing of the symbol π in the expression concerned, which was indistinct in some copies of the journal.]

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FLOW-COAT PAINT SYSTEM

SIR, With reference to your note on page 466 of the issue of October 12 regarding the flow-coat paint system at the Nacton Works of Ransomes, Sims and Jefferies, Limited, may we point out that Docker Brothers, initially, and Lewis Berger (Great Britain), Limited (who are the present paint suppliers), subsequently, have both collaborated with the plant makers. There was no collaboration between Docker's and Lewis Berger.

Yours faithfully,
A. BEAVAN,
Industrial Sales Manager.

Lewis Berger (Great Britain), Ltd.,
London, E.9.
November 15, 1956.

★ ★ ★

FRUSTRATED LEADERS

SIR, Lord Citrine once made the point that, in industry, management is responsible for a human-relations factor as well as for the more obvious economic and technological factors. He suggested that management paid insufficient attention to this human-relations factor; and that this might be one cause of industrial unrest. If this is true, and I think it is, then I suggest that management's failure is due not so much to any lack of realisation of their responsibility in this respect as to a lack of imagination in their approach.

The economic and technological factors in industry are susceptible of scientific treatment, and success in control of these factors can be assessed accurately and continuously. Control of the human-relations factor, however, is still more of an art than a science, and loss of control of this factor is seldom immediately apparent. Deterioration in this factor cannot be directly measured but can only be estimated; and there is usually a time lag that makes it difficult to link cause and effect.

A purely scientific approach is therefore out of place in dealing with the human-relations factor; yet management, pre-occupied with the material needs of its employees, persists in trying to deal with the problem along these lines. In general, as management becomes more scientific, it also becomes more reluctant, or unable, to recognise that employees are still human beings; that human beings are often unreasonable and unpredictable in their behaviour; and that this fact cannot be altered and must therefore be accepted.

First and foremost, a human being requires and demands recognition as such, i.e., as an individual; it is not sufficient to provide only for material needs, however adequately or even luxuriously this may be done. And when this fact is not recognised by management, employees eventually come to resent it, quite rightly and perhaps even unconsciously, as an affront to their dignity. How often is this the answer to management's inability to account for the discontent and ingratitude of their apparently well-treated employees?

Success with the human-relations factor in industry must start on a personal level; it is fundamentally and inescapably a man-to-man affair; in fact, essentially it is a matter of leadership at all levels. And no set of regulations, however well conceived or exactly applied, can substitute for lack of such leadership. There can be no permanent success with the human-relations factor unless each group of employees can look with confidence to one accessible individual who not only directs their work and knows them personally, but who is also felt to be a protector of their interests and their immediate spokesman with the powers that be.

How large such a group of employees can be must depend in the main on the ability of the individual leading it and on the time that he is enabled to devote to this aspect of his work. In times past, such an individual might have been a manager, but in these days of ever larger organisations he is unlikely to be more than a departmental head, and may be only a section leader or senior foreman. However, whatever their position, it is on these group leaders that an organisation must depend for ultimate success in dealing with the human-relations factor.

Now men in the position of group leaders cannot effectively function as such without both management recognition of, and support for, this aspect of their work. Recognition of the function without the support to make functioning possible is not enough. To-day, with central separate departments set up to deal with employment, welfare, etc., management is tending to deal more and more directly, but more and more impersonally, with the individual employee, and is thereby rapidly destroying the whole business of group leadership even when its desirability is recognised.

With the present trend towards standardisation and centralisation, specialists now draw up rigid procedures for almost everything. How a job shall be done; how many men are required to do it; and what shall be done in any set of foreseeable circumstances, human or technical: all now tends to be laid down in writing. The group leader is left with less and less scope for the exercise of his initiative.

In the Forces nobody thinks the worse of an officer who badgers authority above him on behalf of the men he directly controls. It is recognised that morale largely depends on the individual's belief that someone easily and directly accessible to him has the desire, interest and ability to see that he gets just treatment and recognition. This is equally true of industry, but to-day it is a brave and persistent group leader who would try to do the same.

If it is a matter of pay or promotion, let the employment or staff department deal with it; if it is a matter of working conditions or a personal matter, there is the welfare department. And, in large organisations, the relations between an official of one of these specialist departments and the individual employee can seldom be other than entirely impersonal.

The specialist department deals with employees in bulk; and, unless group leaders are enabled to intervene between the employee and the official of the specialist department, then the latter, lacking personal knowledge, must deal with each case according to the book. But as no book, as yet, can cover adequately the field of human relations, mistakes and injustices must occur; and one gross mistake in this field can do more damage than a thousand fair and just decisions can do good. How many strikes and walk-outs have occurred over a triviality?

Unfortunately, the officials of these specialist departments are usually reluctant to seek, or even to tolerate, the intervention of group leaders between themselves and the individual employee. It is so much quicker and simpler to go by the book rather than make the effort required to evaluate fairly the intangible human factor that may be present. Consequently, the group leader who does make the effort to intervene, from a sense of responsibility, usually finds himself thwarted and unpopular; he may even come to be regarded, unjustly and to his detriment, as hostile to management.

The inevitable result of all this is a mutual distrust between an impersonal, even if benevolent, management on the one side, and resentful and suspicious employees on the other. In between are the key men who could, perhaps, solve many of the problems of industrial unrest. Frustrated and helpless, because management increasingly fails to give them the support and confidence they ought to have, these men in turn cannot win the support and confidence for management of the rank and file of the organisation.

Bureaucracy is the death of morale; and in a competitive organisation is likely to lead ultimately to the death of the organisation itself. If British industry is to compete successfully in a world growing ever more competitive it should examine critically some of the present internal organisational trends that have resulted from the growth of its parts into ever larger individual units.

Yours faithfully,
H. W. S. MARSHALL.

P.O. Box 1,
Kirkuk,
'Iraq.
November 26, 1956.

Weekly Survey

Cover Picture: *The shaping, by panel beating, of unusually intricate stainless-steel components is shown in the illustration. They form part of the ducting for a cowling fitted over the engine of a helicopter and are polished after assembly. The two formers on the bench are used in the shaping of the work. Stainless steel is a difficult metal to work in this way.*

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C.E.A. Plan Bigger Yet

The Central Electricity Authority are planning to instal, as part of their programme of power station construction for 1962, a turbo-generator of 550 megawatt capacity, which is very much larger than any now in operation and, as far as is known, is larger than any other unit at present projected anywhere in the world. The programme will include, as well, a number of turbo-generators each of 275 MW capacity, also representing an advance on the 200 MW sets which are at present the largest on order for power stations in this country. The 550 MW machine will have an output greater than the present output from any one of the Authority's existing power stations.

The decision to build a machine of this large capacity is the latest step in a development programme aimed at effecting reductions in the costs of generation by increasing the size of generating sets and boilers. Unfortunately, there is a factor outside the sphere of the electricity supply industry which places limits on the size to which generator sets can be developed, namely the restriction on the maximum weight that can be transported by road. The maximum rating of generator which this limitation has made it practicable to contemplate commissioning in 1962 is 275 MW. This gives set sizes of 275 MW with a single-shaft tandem-compound arrangement of the turbine, or 550 MW with a two-shaft cross-compound arrangement, where two generators are employed. If it were not for the loading restriction, sets of 1,000 MW would be quite possible.

While the 550 MW unit promises even greater capital economy compared with the 200 MW machine than does the 275 MW unit, both have their proper application in the system, and both types have therefore been included in the programme. For both, the initial steam conditions will be 2,300 lb. per sq. in., 1,050 deg. F., with one stage of reheat. These conditions are comparable with those adopted for the 200 MW units already in the programmes for 1959, 1960 and 1961, and also with those of the latest American sets, although at one time higher temperatures were envisaged there.

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Oil Supplies

The latest move in the bewildering situation of the past three weeks occurred last week-end when the United States Government authorised the 15 American oil companies to bring into operation the combined emergency plans they have prepared to help Western Europe. U.S. officials estimate that 500,000 barrels a day should reach European ports within a month, compared with 300,000 barrels a day at present being imported from the Gulf and Caribbean areas. Earlier estimates had put the figure as high as 1 million barrels, but the shortage of tankers will make this impossible. The Ministry of Fuel and Power thought that additional oil equivalent to 15 per cent. of western Europe's total needs could be obtained from the western hemisphere. As imports from the Middle East are now down to 60 per cent. of normal, the additional supplies from U.S. sources will barely suffice to raise the total to 75 per cent. of average requirements, on which the Government's present rationing scheme is based. It could be that the diversion of large U.S.-bound round-the-Cape tankers to U.K. ports will further improve the situation, or that more ships will be found somehow. Viewed in the best light possible, American assistance will mean that we shall obtain 80 per cent. of our requirements in January.

The more pressing, and the more persistent, shortage is likely to be of gas and fuel oils. A cut of more than the " official " 10 per cent. may well be necessary during the next few weeks, with unavoidable dislocation of road transport and industrial output—particularly in the gas and steel industries. The oil companies say that the shortage of petrol is far less than is generally supposed; much of the apparent shortage is the measure of the overfilling of petrol tanks by motorists and the holding back of supplies by garages and filling stations in anticipation of a price increase.

A most important aspect of increased imports from dollar sources is the drain on our currency reserves and on those of other European countries, though special American aid may be granted to subsidise shipments for military purposes. Offers of extended credits by the American oil companies and of loans from the Import-Export Bank may be made to ease the situation. Nonetheless, the dollar cost of the imports is likely to set a ceiling to the quantities that can be purchased. All-out economy, and rationing, cannot be avoided until the pipe lines are repaired and the Suez Canal open to traffic.

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Office Machinery Expansion

The office-equipment industry continues to expand. It is announced that United Kingdom exports in October were the highest ever recorded in any month and nearly £85,000 greater than those for October, 1955, previously the highest monthly total.

While output of conventional office machinery thus appears likely to establish a new record this year, the office-machinery field is likely to be dominated within the next year or two by computers. The ten United Kingdom companies at present manufacturing electronic computers have orders on hand worth well over £14 million, involving the supply of more than 200 machines, together with their ancillary equipment. Many further orders are being negotiated and the established production plans of these companies envisage the output in 1958 of between 300 and 400 machines, worth more than £30 million. By this time, at least three more companies who have not yet finalised their production plans will also be either manufacturing or supplying electronic computers in the United Kingdom, while a further three or four companies are also planning to enter the field. The majority of the electronic computers now on order are intended for commercial accounting work.

Deliveries of conventional accounting and similar machinery in 1955 amounted to £19,740,000, so that it is probable that computer production will eclipse that of the conventional equipment within a short time.

The successful development of computers requires a detailed appreciation of the processes which they are to serve. It is natural, therefore, that this has led to associations between computer manufacturers and office-machinery manufacturers. Although previously announced associations have been mainly directed towards marketing, it is also natural that manufacturers in the two fields should work together on development problems.

In the latter category, the formation was announced last week of a new company, Computer Developments, formed jointly by the General Electric Company and the British Tabulating Machine Company. British Tabulating Machines are already in the market with computers for accounting purposes, but further developments in the business machine field are to be expected from this latest marriage of intellects.

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Solving Traffic Problems

A critical examination of schemes and proposals to solve traffic problems in this country, and more particularly those of large towns, is made in a broadsheet published by Political and Economic Planning (P.E.P.). The many different manifestations of the problems in this country are analysed, together with the solutions which have been suggested so far. The authors conclude that no long-term solution to the traffic problems of large cities can be found in any political road or rail scheme: " A whole-hog policy of provision for all potential traffic desires in central areas would demand reconstruction on a scale which cannot be contemplated." The only permanent solution is to de-congest central areas: moving out offices and retail centres and the careful location of large concentrations of new industry are the only possibilities.

To improve the present situation, P.E.P. advocate new underground railways, which are a better investment than urban motor ways in areas of high land values. The one-way operation of streets should be considerably extended, particularly in London. Parking must be regulated and expensive enough to deter the " commuter " who brings his car in the morning and leaves it parked all day. There is a great deal of scope for better planning of urban traffic, and an urgent need for greater co-ordination of road, rail and land-use planning in large towns, particularly London. Traffic management is badly in need of overhaul: " Present arrangements in London date from 1924." Prominent among P.E.P.'s suggestions for immediate action is the promotion of traffic engineering —which they describe as " a science hitherto neglected in this country "—and the collection of traffic data. Much work will be required on the present plan and projects if the benefit/cost ratio is to be realistic.

The present gloom of petrol rationing should not be allowed to divert attention from the basic issues brought out by this broadsheet. Nor should the relatively empty streets of London make us feel all is well again. Our crowded country cannot live without efficient transport. The Government's concern with this, leading to a committee being set up to examine London's traffic problems, is the subject of a Human Element note on page 736. P.E.P.'s well-informed broad-sheet will help all concerned to see the wood from the trees.

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The Consulting Engineer in Industry

The functions of the consulting engineer in industry are excellently described in a four-page booklet published by the Association of Consulting Engineers. The Council of the Association address themselves to " those who are concerned with the expansion of industry," including directors and financial and technical managements. Britain has a very good core of consulting engineers, with a long history of valuable service to industry. It is in this field, however, that some of the most acute overseas competition is being experienced. American, Russian and German consulting engineers, and particularly the former, have been most active in overseas territories preparing scheme after scheme for power plants, steelworks, inland transport, harbours and for other items of basic industrial development—thus paving the way for contractors and plant manufacturers of their own country. For this reason alone it is vitally important that British consulting engineers should receive good support from the industries they serve. There has been since the war a tendency for large companies, and more

particularly the nationalised industries, to engineer a growing proportion of their own expansion schemes. This has become more marked in recent years with the establishment of central design departments at the Central Electricity Authority and the National Coal Board.

Yet the need for their services is becoming all the greater as the requirements of industry are served increasingly by highly specialised suppliers operating in narrow fields. As the booklet points out the consulting engineer has to keep up-to-date with techniques in a wide range of industries; for example, "foundation problems are different on each site, and inadequate appreciation and failure to adopt the best solution can either result in subsequent troubles or in excessive expenditure." There is little doubt that experience of preparing schemes is without substitute and it is rare that a contractor has adequate designing knowledge and skills, or an operating concern enough experience of different conditions. The other main function of the consulting engineers—that of obtaining tenders and selecting them, planning and co-ordinating a project with subsequent inspection—is as vital. In an industrial world of increasing specialisation the function of the skilled co-ordinator with broad knowledge is becoming indispensable. The mastery of techniques with broad applications counts just as much as the technology of products.

* * *

Commercial Vehicles

Leyland Motors Limited announced at the end of November that, with five weeks to spare before the end of the year, their production had already exceeded the total for the whole of 1955. Leyland are thus continuing, though on a more modest scale, the great expansion which has taken place in output over the last few years. The company state that 1955 showed a 21 per cent. increase in output over 1954, when the output was in turn 12 per cent. higher than that of 1953. This expansion has been marked by steady increase in the proportion of vehicles exported, exports in 1955 being over 100 per cent. greater than in 1953.

While this achievement provides a welcome contrast to the general picture of recession in the motor-vehicle industry, it should perhaps be borne in mind that the most significant part of the expansion took place during the first six months of the year, and the outlook for commercial vehicles as a whole is not so bright as it appeared earlier in the year.

The output figures for the first half of 1956 showed that the production of commercial vehicles was continuing to expand at a modest though significant rate in spite of the adverse factors affecting the motor-vehicle industry as a whole. The total number of vehicles and chassis produced was 177,951 compared with 167,480 for the same period of 1955. Though output rose in all categories, the most marked expansion took place in vehicles of over 6 tons capacity, output of which rose by over 40 per cent. compared with the first six months of 1955.

In the third quarter of the year, however, overall output fell below the 1955 figures in all groups, the trend being most marked in the lightest vehicles. At the end of the third quarter, only vehicles of over 6 tons capacity could show an increase in output over 1955, although this was still 23 per cent.

In the export field also, the heavy-vehicle manufacturers have together fared a good deal better than manufacturers of commercial vehicles. For the first nine months of the year, exports of vehicles over 6 tons rose from 2,185 in 1955 to 2,468 in 1956, while total exports of commercial vehicles fell from 108,962 to 103,193.

In spite of the fall in output in the third quarter of the year, modernisation and expansion schemes continue to be put in hand, the most recent to be announced being at Leyland's. It is believed that the majority of the expansion schemes of the major heavy-vehicle manufacturers are designed to provide about 20 per cent. greater capacity over the next year or two.

* * *

Domestic Refrigerator Sales

Mr. Morris Craig, sales manager of Electrolux, and vice-chairman of the Domestic Refrigeration Development Committee, said last week that nearly one million domestic refrigerators have been exported since the industry resumed quantity production in 1948. If components for assembly abroad are included, the total value of exports of domestic refrigerators in the past nine years has been about £100,000,000.

On the home market, sales of domestic refrigerators appear to have been affected very much less than those of other domestic appliances by hire-purchase restrictions and the increase in purchase tax. This is probably due largely to the efforts of the Development Committee, which was set up early this year to promote the development of home and export markets. The members include eight of the leading manufacturers who claim to represent about 80 per cent. of total production, namely, Electrolux, Frigidaire, Pressed Steel, G.E.C., English Electric, Nash Kelvinator, Morphy-Richards and Hotpoint.

In the first six months of 1956, the production of domestic refrigerators totalled 133,000 compared with 127,800 in the same period in 1955. There was, however, a fall in value of deliveries from £9·3 million in the first half of 1955 to £8·8 million in the corresponding period of 1956. This appears to have been due to strong competition in export markets which forced a reduction in selling prices and to the fact that increased purchase tax has resulted in concentrating demand in the home market on the smaller sizes of refrigerator. Sales on the home market in 1956 appear to have been adversely affected by the weather since while the value of deliveries in the first six months of the year declined by only £138,000 compared with 1955, the corresponding fall in the two months July and August was £470,000.

The Development Committee believe that if export markets are to be developed in the face of foreign competition a strong home market is essential. In the United States between 85 per cent. and 90 per cent. of houses wired for electricity are fitted with refrigerators, but in this country the percentage is less than 10. There is, therefore, a very large potential market quite apart from replacement demand which is already considerable.

* * *

Falling Profit Margins

Of the two major threats to the prosperity of British engineering—oil shortage and wage claims—only the latter has begun to be reflected in the annual statements of the chairmen of companies. There is deep and almost universal apprehension lest a major wage award should exclude our products from export markets. To expect higher profit margins, or to be able to absorb a rise in labour costs, without dropping profits is limited to very few in fast-growing industries. Sir Ian Stewart-Richardson, chairman of Vokes Limited, drew attention to this general tendency, commenting that in the case of his own firm he could "have forecast another favourable year but with the proviso that profit margins are definitely decreasing and that the price factor is becoming increasingly important in obtaining orders." This is echoed by Mr. Frank H. Farrer, chairman of Villiers Engineering Company, Limited, who reports a reduction of more than one-quarter in profits arising from lower margins. C. J. Hampton, Limited, makers of "Record" tools, report an increase in profits of 1 per cent. compared with 12 per cent. in respect of sales.

This fear of losing trade through rising prices extends over a wide range of industries. Seddon Diesel Vehicles Limited report a slightly reduced profit despite a 15 per cent. increase in turnover. Mr. R. H. Seddon commented that their refusal to raise prices was right, in view of "the growing competition from Continental manufacturers." Mr. S. Bramhall, chairman and managing director of Smith's Stamping Works (Coventry) Limited, warns the vast increase in the group's profits (year to August 4) from £215,000 to £421,000 cannot be maintained or that "profit margins can continue at the same level." The directors of Associated British Engineering, Limited, the makers of Diesel engines, report a somewhat lower group profit for the half year ending October 30, as "increased costs have reflected a lower margin of profitability on some of the Group's products." The point was perhaps made most clearly by Mr. C. L. Hill, chairman of the Heenan Group of companies, who said "changes in the economy, such as rising costs of production on a national scale and credit restrictions, take time to show up in the accounts but is becoming increasingly evident that the continuous rise in costs over a number of years is now having its effect on profit margins; buyers in overseas markets and at home are resisting price increases and it is frequently a case of a sale . . . at a low profit or no sale at all."

* * *

Relentless Growth in Electrical Engineering

The outlook of the British electrical engineering industry was well expressed by Mr. Albert Parkinson, chairman of Crompton Parkinson Limited, in his statement to the company's shareholders: "Notwithstanding any concern for the immediate future I feel now as I have always felt about the electrical industry, and I have no doubt whatever that its further expansion is as inevitable as it is, in the long term, incalculably great." His report is filled with news of expansion of manufacturing capacity at home and abroad in the Group's 14 factories, three of which are overseas (India, Australia and Canada). The fundamental truth of Mr. Parkinson's statement applies with equal force to all companies whose annual statements and reports are available, whether manufacturers of electrical plant, cables or household appliances. Aerialite Limited, the Stalybridge electric cable and aerial manufacturers, report increases in demand, sales, turnover and productivity, and profits are up by 27 per cent. in spite of the effect of the credit squeeze and hire purchase restrictions on the demand for television aerials. Government policy appears to be just as ineffective in the case of J. and F. Stone Lighting and Radio, Limited, whose profits—earned mainly from the retail sale and renting of radio and television sets—have risen by one quarter to over the £1 million mark. Morphy-Richards Limited, in a different field but also dependent on the sale of electrical appliances to the public, report an increase in sales of 18½ per cent. for the year ended June 30. Mr. H. D. Drysdale, the company's chairman, said that they accounted for over 90 per cent. of the country's production of automatic irons and 60 per cent. of electric toasters, and emphatically states his belief that "high quality, trouble-free domestic appliances produced with the lowest possible profit margin will always find a market."

A company making instruments and precision engineering products, The Solartron Electronic Group Limited, provides the success story of the week. For the year ended June employment has increased by 40 per cent., sales by 90 per cent. and trading profits have almost trebled. The number employed has risen from 240 in 1954 to 550 last June and is expected to expand to about 675 during the current financial year. A more confident annual statement than that of their chairman and managing director, Mr. John Bolton, would be hard to find.

WOMEN ENGINEERS

When the Women's Engineering Society was founded 38 years ago, its primary objective was to open the doors of the engineering industry to the few strange women who wanted to penetrate this almost exclusively masculine field. To-day, although there are still many firms that have not yet considered the possibilities of employing women as professional engineers or of offering them apprenticeships, and although in general the opportunities open to women are considerably more restricted than are those for men, the Society is beginning to find that the problem of finding the right girls to fill the vacancies that are brought to their attention is a bigger one than that of finding openings for female candidates.

There are signs, however, that school-leaving girls are becoming increasingly interested in the technical opportunities available, as a result of the publicity given earlier this year to the Government's plans for encouraging technical education in the schools, technical colleges and universities. Student and graduate apprenticeships are open to girls in several firms; trade apprenticeship for the girl who wishes to become a skilled craftswoman is, however, less easily come by, although she will find ample opportunities in the W.R.A.F. and W.R.A.C. and to some extent in the W.R.N.S. It must be admitted that several firms taking on young girls from school as apprentices have been unfortunate in their selection; some of these girls have found their colleagues and working conditions uncongenial and have not stayed the course.

Up to the present, the number of women entering the professional engineering field every year has remained small, and fairly constant. How far this is due to the fact that for most women engineering has no intrinsic appeal, and how far it is the result of inadequate educational opportunities—only a few girls' schools are at present suitably equipped for teaching science and arousing the interest of potential technologists—will probably become apparent when the Government's plans begin to take effect.

Just how many women are engaged in responsible engineering positions is not easy to assess, since not all of those suitably qualified have chosen to join either an engineering institution or the Women's Engineering Society. In the three major institutions, there are in all about 40 women corporate members—more than half being attached to the Institution of Electrical Engineers. In the professional grades of the Royal Aeronautical Society, which includes mathematicians and physicists as well as engineers, there are some 20 or so women.

Although probably the majority of women engineers are to be found in the electrical and aeronautical industries, some have also entered the fields of naval architecture, marine, locomotive, and automobile engineering, heating and ventilating, civil and sanitary engineering, as well as technical publishing and journalism. They are being increasingly sought as technical editors by the engineering institutions and learned societies. Women are most readily accepted in research and development departments and, particularly in Government research establishments, are recognised as being capable of directing a section. At the Royal Aircraft Establishment, for example, two of the 20 women scientific officers employed have attained the status of senior principal scientific officer responsible solely to the Director. One of these is a theoretical aerodynamicist, and the other is a mechanical engineer working on heat exchangers and refrigeration.

The reluctance of the male sex to acknowledge feminine technical ability appears to vary inversely as their own mental calibre. The woman research engineer is not likely to meet with any lack of co-operation on account of her sex. It is rather more difficult, although by no means impossible, for a woman to achieve an authoritative position in a design office where she may be in charge of a number of draughtsmen but it is still more difficult on the production side, and probably, in a large engineering works, practically impossible for a woman engineer to rise to any worth-while position. Some women whose interests lie in production engineering have overcome this by setting up their own organisations and, in at least one case, by employing only women operatives. It is, nevertheless, in the field of production, in its work-study aspects, that women have made the greatest impact on engineering, through the pioneering work of Dr. Lilian Gilbreth in the United States; and in Britain to-day, Miss Anne Shaw is an acknowledged authority.

* * *

ELECTRICAL ACCIDENTS AND THEIR CAUSES

Inadequate Switchgear

The report of H.M. Senior Electrical Inspector of Factories for 1954, which has recently been published by H.M. Stationery Office under the title "Electrical Accidents and their Causes," is, as always, a document of great interest. In addition to a considerable amount of raw statistical detail regarding the various categories of accidents, it deals informatively with such subjects as portable apparatus, electrostatic hazards, earthing and automation and, by describing certain typical accidents, indicates lines which should be followed in design, construction and operation of equipment.

During the year under review there were 707 accidents, 33 of which were fatal. This is the same number as in 1946 and, as during the intervening period the use of electricity has greatly increased, the result may broadly speaking be considered to be satisfactory. In addition to those 33 fatal accidents, which were reportable under the Factories Act, a further 89 electrical accidents in places outside the scope of the Acts came officially to the notice of the Department, thus raising the total to 122. All these accidents occurred on alternating current systems, 19 of the 33 at voltages below 250 volts. Two occurred at voltages between 250 and 650 volts; seven at voltages from 650 to 5,000 volts, and three at voltages over 10,000 volts. An analysis shows that the greater number of these accidents were to the unskilled class of worker, although there is also evidence to indicate that in certain classes of incidents equality is more often approached.

OVERLOAD EFFECTS

The number of reported failures of electrical equipment in power stations was rather lower than usual. It included two internal disruptions of large power transformers, which were believed to be traceable to previous sustained heavy overloads, and failures in 6·6 kV and 11 kV switchgear of rather an out of date pattern. Maximum demands of some tens of megawatts in areas where loads were previously sparse resulted in the introduction of 132 kV systems and heavy reinforcement of the 33 kV and 66 kV distribution networks. As a result, short-circuit conditions increased from a negligible value to amounts where they have become a serious problem. This rendered many of the substations obsolete, and made many of the operating practices previously in use hazardous. In fact, operating methods such as manually closing and re-closing a circuit-breaker on a fault must be reconsidered.

In this connection constant attention is directed to the requirements of the regulations regarding the making and breaking capacity of switchgear. As a result of a country-wide survey it was found in one area that 41 per cent. of the high voltage switches were of inadequate rupturing capacity, and that in one large city alone the cost of replacing them by more satisfactory equipment would be about £1·75 million.

LAPSES OF MEMORY

There are, of course, numerous reasons for the various accidents that are reported, but it is significant that many of them are due to lapses of memory or mental aberration on the part of competent engineers, who certainly should know better. An example is given in the report concerning three engineers who were investigating the loading of a large substation in which there was an open-type distribution board. One of them was taking readings of the current in three phases of a three-pole switch. In spite of the fact that the clearances were ample for normal working conditions, a three-phase flash-over was caused by the employment of an uninsulated "tong-type" instrument which was primarily intended for use round insulated fuse carriers or cables. The busbars were supplied direct from a 750 kVA transformer and although the circuit-breaker on the high-voltage side of this unit operated very quickly and the material damage by arcing was not very great, all three protagonists received extensive superficial burns.

PORTABLE APPARATUS

As usual, a high proportion of both fatal and non-fatal accidents were due to portable apparatus. Equipment operating at the normal voltage of 240 volts can, it is pointed out, only be considered safe indoors in dry atmospheres and where there is no earthed metalwork or conducting flooring. Except when these ideal conditions are present a defect in the portable apparatus may well cause an accident, to guard against which the best precaution is to reduce the voltage to 110 volts or even to 50 volts. It is therefore recommended that wherever possible a low-voltage distribution system should be installed or, where this is impracticable, a specialised protective system should be adopted. Even then, there is need for care in the installation of plugs and sockets and in the means of producing the reduced voltage.

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Obituary

MR. J. E. STEEL

Industrialist in the North

It is with regret that we note the sudden death of Mr. John Eric Steel which occurred at his home, Netherwitton Hall, Morpeth, Northumberland, on November 6. Mr. Steel, who was only 49 years of age, had been for 20 years the chairman and managing director of Steel and Company, Limited, engineers, Crown Works, Sunderland. He was a director also of 14 engineering and shipbuilding companies in the United Kingdom, and of five concerns established overseas, and was an underwriting member of Lloyds.

He played a leading part in the industrial life of the North of England and at the time of his death was President of the Northern Regional Council of the Federation of British Industries, having succeeded Colonel G. E. Angus in that office in February of this year. He was, moreover, chairman of the finance committee of the North-East Industrial Development Corporation and vice-chairman of the Peterlee Development Corporation. Mr. Steel was a past-president of the Institution of Heating and Ventilating Engineers and a member of the management committee of the Engineering Industries Association. He served on many committees and panels dealing with labour relations and technical education and was a Justice of the Peace for Sunderland.

ENGINEERING CONTRACTS

10—DEFECTS AND THE MAINTENANCE PERIOD

By F. H. B. Layfield

This is the tenth article of the series being contributed by Mr. Layfield for the guidance of engineers and others engaged on the preparation of engineering contracts. The ninth article appeared in ENGINEERING, *November* 23, 1956, *page* 649.

No matter how close the supervision exercised by the engineer over the work of an engineering contract may be, it frequently happens that, after the work has been completed, defects and defective work gradually become apparent. Sometimes, of course, this is in the nature of things, but, in some instances, defects will only become apparent with the passage of time. For these reasons, it is usual to provide in an engineering contract for what may be described as an interregnum—a period in which, if defects are discovered or work is found not to be in accordance with the contract, the employer may require the contractor to rectify them.

Arrangements of this description are usually effected by providing in the contract that, after the construction has been completed, two special provisions shall apply. These would include, in the first place, that there should be a stated period of so many months or years during which the contractor may be given notice of defects which have arisen and, secondly, that, until the end of this period, the employer is entitled to retain a fixed part of the contract price, usually in the form of a given percentage. This period is properly described as the *defects liability period*. Sometimes this idea of providing for a period after the completion of the job, during which certain works can be done, is carried rather further and it then takes the form of a maintenance provision. During a *maintenance period*, the contractor is placed under a duty to maintain the work completely, and this, of course, is a much wider responsibility than a mere liability to make good defects which may have arisen.

The most onerous type of obligation is that by which the contractor is placed under a duty to maintain and repair the contract works within the stated period. Sometimes, also, provision is made for a combination of these different responsibilities. Various names are given to such periods, which begin after completion of the works, and these names are sometimes used in a rather confusing manner. Strictly speaking, most contracts which appear to provide for a maintenance period actually provide only for a defects liability period. As the term maintenance period is in such widespread use in that sense, it will be convenient to use the phrase here as though it had the same meaning as a defects liability period.

FIXING THE MAINTENANCE PERIOD

There are two methods by which the duration of the maintenance period can normally be fixed. By one of these, the engineer can provide for the length of the maintenance period when he puts the contract work out to tender. This is usually done by stating that the maintenance period will last for a given number of months after the completion of the work. The alternative method, and in some ways the more satisfactory of the two, is to state in one of the clauses of the contract the length as well as the details of the maintenance period. This latter system is the one which is adopted by the Institutions of Mechanical, Electrical and Consulting Engineers in their standard forms "A1," "B1," "B2" and "B3." When deciding what he should provide for in the way of a maintenance period, the engineer will do well to consider the advantages and disadvantages which the maintenance period possesses from the point of view of the employer's interests. The advantages which the fixing of the maintenance period has for the employer are plain. By its means, there is established a period during which he has a clear and definite method of securing that defective work can be remedied. Moreover, a set procedure is provided whereby this work can be speedily and effectively undertaken, and arrangements can be included by which the employer will be entitled to carry out the work himself in case of default. Finally, but by no means least, he has the advantage of retaining a portion of the contract price, as security for the due performance of the arrangements made.

Nevertheless, such provisions have a disadvantage. If there were no mention of any such period, and nothing similar were provided for in the contract, the contractor would normally be liable to an action in the courts, in respect of defective work, for up to three years after the construction had been completed. In special circumstances, too, this period may be extended to as long as six years. If, however, a period is provided during which the contractor must remedy defects, then this sets a very definite limit to his liabilities. Once the final certificate has been given at the end of the maintenance period, the contractor cannot thereafter be successfully sued under the contract for defective work, except where there has been fraud, or where certain other very limited special circumstances exist.

These considerations should be in the engineer's mind when he gives thought as to what provision he will make in the contract about the maintenance period. The question of how long the period should be is largely a technical one, turning upon matters which are outside the scope of the law. The engineer should remember, however, that when once the maintenance period is over, he is virtually without any further remedy.

DEFECTS BEFORE COMPLETION

Defects or defective work which become apparent before the contract work is completed, or substantially completed, are usually the subject of separate provision in the contract. The arrangements to be made for the rectification of defects before completion are usually fairly simple. A notice to the contractor is necessary but, thereafter, matters can normally be taken in the engineer's stride. The contractor is still on the site and the rectification of defects can take its place in the normal run of work. It is those defects which appear after completion that are the main problem. It may be added here that, while it is normal to speak of *completion* of the works, it is not, of course, necessary that the whole of the contract work should be completed before a maintenance period begins. In many contracts, completion will take place by stages and, accordingly, there will be a number of separate maintenance periods, corresponding to the completion of each stage of the work. Furthermore, when the overwhelming bulk of the contract work has been executed, the work may be described as *substantially completed*, although a few very minor operations may still remain to be done.

A typical standard provision for the maintenance period is to be found in form "A" of the Institutions of Mechanical, Electrical and Consulting Engineers. Clause 29 (i) of that form provides that

> "For a period of 12 months after the works or any portion thereof have been taken over the contractor shall be responsible for making good with all possible speed any defects arising from defective design . . ., materials, or workmanship or from any act or omission of the contractor that may develop in the works under conditions provided for by the contract and under proper use."

It will be observed that this provision, like many others, requires the contractor to remedy defective design. It is, however, only reasonable that a corollary should be made which prevents the contractor from being called upon to put right a design which either was not his or to which he has objected. Consequently, the clause just quoted exempts the contractor from responsibility for a defective design "made, furnished, or specified by the purchaser *and* for which the contractor has disclaimed responsibility in writing within a reasonable time after the receipt of the purchaser's instructions."

DEFECTS FOUND BY CONTRACTOR

It may often be the case that the contractor is the first to observe a defect in the works and the question may arise, therefore, as to whether, in such circumstances, the engineer is expected to give notice to the contractor of the details. The contract usually requires expressly, as in the "A" form, that

> "If any such defect shall occur the engineer shall inform the contractor thereof stating in writing the *nature* of the defect."

Accordingly, the engineer will always be wise to see that a notice is given of any defect or defective work whoever it is that may have discovered the fault. He should not rely upon the fact that the contractor may already know of the defect in question, since it is not clear at law whether the contractor could be held responsible in cases where he knew of the existence of a defect and did not put it right, on the ground that he had not received due notice from the engineer. In this connection, it is as well to make sure that the form of notice to be employed for the notification of defects is settled as early as may be and that, if possible, a form of notice should be agreed at the time the contract is made. Finally, it should be noted that most clauses require the engineer to state in the notice the *nature* of the defect and not to state what is to be done.

WHEN THE CONTRACTOR DEFAULTS

It has already been stated that one of the advantages of the maintenance period to the employer, and, of course, to the engineer, is that provision can be made by its means to enable defective work to be replaced, should the contractor fail to do so. Such an arrangement as this appears in the "B3" form of the Institutions of Mechanical, Electrical and Consulting Engineers, which provides that

> "If any defects be not remedied within a reasonable time, the purchaser may proceed to do the work at the contractor's risk and expense, but without prejudice to any other rights which the purchaser may have against the contractor in respect of the failure of the contractor to remedy such defects."

The important thing to bear in mind about such default provisions is that, normally, they may only be implemented if the contractor has received the notices required under the contract and, also, that any other necessary formalities which may require to have been carried out have been observed beforehand.

The object of the maintenance period is to see that each part of the work has a period after completion during which its condition and performance may be properly assessed. To this end, it is desirable, if parts of the work are replaced as a result of a notice given under the defects clause, that these replaced portions shall have the same full periods during which their performance can be assessed. It by no means follows that this will be the case, unless specific provision is made to that end. It is for this reason that the "B3" form goes on to provide, in connection with its maintenance period provisions (clause 31) that

> "If the contractor replaces or renews any portion of the work, the provisions of this clause shall apply to the portion of the

work so replaced or renewed as if that portion had been taken over on the date of replacement or renewal."

The use of the expression "taken over" refers to the moment under the "B3" contract when the maintenance period begins to run.

TESTING EQUIPMENT

Very similar considerations apply to the testing of equipment. It may happen that a particular piece of plant is installed as part of the contract works and duly tested. Clearly, if this is later found to be defective, after a period of running or use, it will need to be replaced. It may happen, though this is not always the case, that the replacement will also require to be tested as the original piece of plant was and this may embrace not only the portion of the plant concerned but other associated parts. Once again, it does not follow that this re-testing will be permissible, unless the contract makes express provision for such a course. The "B3" form meets this difficulty by specifying that

> "If the replacements or renewals are of such a character as may affect the efficiency of the works or any portion thereof, the purchaser may within one month of such replacement or renewal give to the contractor notice in writing requiring that tests . . . be made, in which case such tests shall be carried out as provided . . ."

SEARCHING FOR FAULTS

All the foregoing arrangements may be very convenient, no doubt, in those circumstances where the nature of the defect is known. But, in the very complicated works now frequently undertaken in pursuit of modern engineering contracts, it often happens that, while it is clear that something has gone wrong, the actual nature of the defect is hard to discover. The question arises, therefore, as to whether, in such instances, the engineer can, in fact, give a notice, as required by the contract, which will specify the *nature* of the defect. In order to guard against this situation, and also to ensure the speedy and successful conclusion of the contract work, there is much to be said for including a clause in the contract which will empower the engineer to instruct the contractor to search for a fault. Such a provision is made in the Institution of Civil Engineers' General Conditions, clause 50 of which requires that

> "The contractor shall if required by the engineer in writing search for the cause of any defect imperfection or fault under the direction of the engineer."

It is equally clear that such a provision as this will be quite unacceptable to the majority of contractors unless it is also provided that proper payment shall be made to them should the fault concerned turn out to be one for which they are not themselves liable.

When defects are to be remedied prior to completion, or the taking over, the contractor and his workmen will usually be on the site. Once the completion or taking over has occurred, either the contractor may not be in occupation of the site or he may not have the appropriate workmen or equipment on the site at the time when a defect is found. The contractor must, of course, have proper access to the site at the proper time if the defects clause is to be relied upon by the engineer during the maintenance period. The beginning of this period must be clearly marked. It is usually described by saying that the period will begin when the contract works are completed, or substantially completed, and if there be any doubt as to when this moment will come it should be clearly defined in the contract. This state of affairs is sometimes alternatively described as "taking over." and the same considerations apply. It will be seen that the draftsman will normally be unaware of the difficulties which may arise in practice in deciding when the completion or taking over for all or part of the works has occurred. It is, therefore, for the engineer to consider, when the contract is made, whether these occasions will be sufficiently clearly identifiable. The end of the maintenance period is usually marked by the issue of a certificate. This is best described as the final certificate and this is certainly the safest expression to use. Alternatively, this certificate is sometimes called a maintenance certificate.

SUMMARY

The existence of a maintenance period has advantages for the engineer because it enables him speedily and effectively to have defective work put right within the specified period. It is a disadvantage because, at the end of that period, he is virtually without a remedy if further defects be found. It behoves him, therefore, to consider carefully what length of period best suits his purpose, bearing in mind both the advantage and disadvantage of the maintenance period.

Only the engineer can decide effectively how long the maintenance period should be and he should not be deterred from exercising his judgement in that matter by the specified periods set out in the standard forms. When the contract is signed, much future trouble will be avoided if the engineer will arrange for a clear and unambiguous form to be appended to the contract for use when giving notice of defects. Finally, it is important to ascertain clearly when the maintenance period will begin and when it will end, having regard to the practical nature of the contract works.

Once more, the engineer is the proper person to decide how to define the period.

MANAGING THE FOUNDRY

RECRUITMENT, TRAINING AND EFFICIENCY

In common with other industries, ironfounding is facing an acute shortage of labour, and when there is keen competition for recruits, good working conditions count for much, as do also the prospects and opportunities offered to an entrant. Concerning the first of these points, the efforts made in the industry of late years to make ironfounding safer, healthier and more pleasant for its employees—though this is an end in itself—should also help with the solution of problems of recruitment and turnover. As regards the second point, if the industry wishes to attract young men of the right fibre to be the leaders of to-morrow, it must be in a position to assure them that there is scope for their abilities and the means of developing their talents.

The above paragraph summarises briefly the speech delivered by Mr. Iain Macleod, Minister of Labour and National Service, when opening a conference entitled "Men, Management and Metal," held in London by the Council of Ironfoundry Associations recently.

The conference was concerned with management, technology and education, the organisers pointing out, firstly, that 200 out of 220 leading firms in the ironfounding industry are of the opinion that the industry should define and facilitate up-to-date training for its managers. In the second place, they consider that the ability of the industry to produce a quality product economically depends on the scientific and technical control of foundry operations. Thirdly, it is emphasised that the action taken to-day to recruit and train new men will determine how well the industry is run to-morrow.

DISDAIN FOR KNOWLEDGE?

Challenging statements were made by Dr. A. Ivanoff, M.Sc., M.I.Mech.E., technical director in charge of research, development and design of Hayward-Tyler and Company, Limited, Luton, in an address, entitled "The Training of Managers and Technologists." He said that during the last 20 years the practical application of scientific facts in the preparation of moulds and in the casting of metal had become more and more beneficial, with the result that, at present, science led and practice had to follow, or lose the race. The average foundry, however, was proud to continue working without any assistance from a technologist. This disdain for knowledge must cease and the persons in charge must get used to the idea that foundry science could be taught in a university—and that it could be taught better and be more correct and more authoritative than the instruction given on the foundry floor.

"We know that British engineering is good. And why is it good?" exclaimed Dr. Ivanoff; because, he continued, 120,000 university-trained scientists and engineers were at present working in the industry. Because at the moment some 30,000 students were learning the latest position of their science in the universities of Great Britain. Ten thousand newly-fledged scientists and engineers would be entering the industry in the present year. Nevertheless, all this was insufficient; many persons were pointing out how much greater was the proportion of academically-qualified engineers in other countries, particularly in the United States and Soviet Russia. A report by the Ministry of Labour and National Service had stated that we, in this country, would have 150,000 university-trained engineers and scientists in the engineering industry in 1959, and 220,000 in 1965. These numbers were not what we ought to have but what we would have. Twice as many, in fact, were needed.

FOUNDRIES NEED GRADUATES

Against this, what was the position in the foundry industry? There was just one college, and that college had the utmost difficulty in obtaining enough students. Engineering schools had to expand feverishly to accommodate all the young men who wished to study. The National Foundry College, on the other hand, managed to entice a "miserable 20 students" into entering it per annum. Since its inception in 1948 the College had turned out 132 graduates and, of these, 26 had come from abroad.

A recent survey had shown that 41 American foundries employing about 32,000 persons had staffs numbering 450 engineers, metallurgists and other professional men. In these foundries the average technologist supported 10 moulders and coremakers.

There were about 50,000 moulders and coremakers in the ironfounding industry of this country and, on the basis just cited, the industry should employ 5,000 technologists. It certainly did nothing of the kind. The whole of the iron manufacturing industry of Great Britain had some 400,000 people at work and employed only 2,000 professional technologists. A calculation would show that ironfoundries in this country employed one technologist for every 110 moulders and coremakers, namely, one-eleventh as many as did the United States. This could well account of the fact that the output, per man, in American foundries was three times higher than it was in ours, and also that the quality was rather higher.

Lastly, turning to the question of manager training. This was just as much a technique as any other. It was a mistaken idea that one learned to be a manager by beginning with a lowly job, gradually progressing to a higher one and, after putting in some 30 years, finishing up as a good manager. The fact must be faced that learning from experience was the most expensive form of learning in existence.

All over the country future managers were being trained and existing managers were being improved. The facilities for training them were available and it remained for the industry to use them.

A number of points were brought up as a result of questions put to a "Brains Trust,"

comprising Mr. K. N. Davis, Dr. J. G. Pearce, Mr. E. Player, Mr. Frank Shepherd, Lt.-Col. L. Urwick and Mr. H. J. V. Williams, after Dr. Ivanoff's address. One of these was that in order to attract entrants the interesting and creative nature of the type of work conducted in the foundry should be contrasted with the often "deadly-dull" routine operations of much of the work carried out in many mass-production shops. There was a need for the managing director or the works manager to give helpful and encouraging talks to foundry trainees periodically and it was important that pressure of other work should not cause these talks to be pushed on one side.

Several speakers referred to the need for building up the position of the foundry industry to a much higher level than it occupied at present. There was, for example, no university course available in this country for a degree in founding. It was emphasised that foundrymen were partners in industry and that their status should be elevated accordingly. In this connection, Dr. Pearce, stated that the most up-to-date school of foundry technology in the world, at present, was to be found in the University of Aachen, Germany.

Another point of interest was in connection with a step taken by one firm to overcome objections on the part of foundrymen to the adoption of work-study methods in the shops. The chief shop steward had been invited to attend a work-study group course in company with the chief engineer, and the result had been that suspicions had been removed and the co-operation of the men on the foundry floor secured. During his final summing up, the conference chairman, Sir Harold West, said that, in general, a man's handling of subordinates was improved if he were given a task in connection with some spare-time activity outside working hours, in which persuasion took the place of the giving of orders.

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NON-DESTRUCTIVE INSPECTION OF AIRCRAFT

Magnetic, Ultrasonic and Radiographic Examination

To survey the applications of modern non-destructive testing techniques in both aircraft manufacture and maintenance, the Society of Licensed Aircraft Engineers recently organised a symposium, held at the University of Southampton, at which demonstrations were given by most of the leading manufacturers of non-destructive test equipment, and discussions were held on four lectures, two of which dealt with radiographic techniques, the other two being concerned with flaw detection by ultrasonic and magnetic methods, respectively.

The latter subject was introduced by Mr. W. H. King of the Central Laboratories of the de Havilland Aircraft Company, Limited, in a paper on "The Practical Application of Magnetic Flaw Detection." He has found it possible to detect both surface and sub-surface flaws to a depth of about 0·06 in. in ferrous materials consistently and accurately. The main part of Mr. King's lecture was devoted to the use of specialised equipment and on techniques and rigs for handling components of awkward shapes and sizes, ranging from the inspection of small parts on site to factory magnetic-flaw detection equipment incorporating motorised materials handling.

IMMERSED ULTRASONIC SCANNING

"An Appreciation of Ultrasonic Flaw Detection Methods" was given by Mr. I. R. Smith, chief inspector of Bristol Aircraft, Limited. Such methods, he considers, are at present limited in their application to airline field maintenance, magnetic, dye-penetrant and radiographic methods being probably more suited to the examination of built-up structures on site. Aircraft manufacturers and materials suppliers, on the other hand, are becoming increasingly interested in the application of ultrasonics to the inspection of materials and components.

Mr. Smith's principal point—in which he was backed up by other speakers in the discussion—is that aircraft manufacturers on the west coast of the United States are well in advance of manufacturers in the United Kingdom in applying ultrasonics, both in the equipment available to them and in the extent to which they are using it. Immersed ultrasonic scanning techniques, he believes, offer far more scope than contact scanning, increasing the possibilities of mechanisation and enabling television-type presentations to be used for general flaw searches, switching over to normal presentation methods for identifying and pin-pointing the flaws.

IN-SITU SERVICEABILITY CHECKS

The current interest of airline engineers in radiography as a tool for routine inspection was the subject of an article in the May 11, 1956, issue of ENGINEERING, in which the use of gamma radiography by British European Airways was mentioned. B.E.A.'s chief inspector, Mr. I. Grant-Murray, reviewing "The Use of Gamma and X-rays in Aircraft Inspection," said that, while retaining gamma-ray equipment for structurally difficult locations, their experience had led them to acquire two portable Fedrex tank-type X-ray sets for general use. An interesting programme on which B.E.A. are about to embark is the X-ray examination of components before overhaul, checking the results when the components are stripped. By this means they hope to develop X-ray inspection to the point where they can use it to determine, *in situ*, the condition of a component whose scheduled life has expired. Owing to the need for conservatism in scheduling component lives, at present many time-expired components withdrawn from service are found to be still serviceable; if it is possible to determine this without dismantling, it may be possible to effect useful economies. Clearly, this is a long-term project calling for considerable advances in radiographic inspection technique.

The need for a close exchange of information on radiographic examination of aircraft structures between manufacturer and the airline engineer was one of the points emphasised by Mr. Grant-Murray; and in the discussion which followed, it was disclosed that Vickers-Armstrongs Limited are encouraging Viscount operators to feed back their varied radiographic experiences for correlation, development and dissemination to other operators of the type.

DETECTING CORROSION

A question of great concern to aircraft maintenance engineers is the early detection of corrosion on highly stressed aircraft skins. Present X-ray equipment can only detect such corrosion after it has reached an advanced state. A new technique, micro-radiography, which goes some way to solving the problem was expounded by Mr. A. Hewett-Emmett, technical sales engineer of Philips Electrical Limited, in a paper on "An Approach to the Detection of Corrosion of Thin Aluminium Alloys." Where both sides of the skin are accessible, they can be inspected by contact micro-radiographic techniques using low-power X-ray equipment (50 kV), similar in characteristics to sets used in dentistry, but converted to small self-contained tank units. The accuracy and sensitivity of this method enables spot-welding on the skins to be thoroughly inspected, and for this purpose the technique has already been adopted by one aircraft manufacturer for inspecting wing skins before assembling to the main structure. Similarly, it has been found possible to detect differences in skin thickness due to corrosion. The technique is still, however, largely experimental; and it is not at present readily applicable to built-up aircraft where intervening structure has to be considered. Mr. Hewett-Emmett considers that aircraft designers should give more thought to the problem of making highly stressed areas of skin accessible to inspection by micro-radiography.

FIBRE PREPARATION

Several unusual design problems were encountered in the construction of the fibre preparation plant at Petmar Industries Limited at Batley, Yorkshire. The plant is intended to process the large quantities of widely differing grades of fibre used in the production of "Raymar" needle-loom carpeting, ENGINEERING, page 732, vol. 177 (1954). At full capacity, the continuous process could produce 5,000,000 square yards of carpeting a year.

Wet freshly dyed fibres are delivered by overhead conveyor to the blending plant from the dyehouse. High-pressure dyeing plant is employed. From the overhead platform to which it is delivered, the fibre is taken by a conveyor, consisting of a creeper sheet and a spiked sheet, into a squeezer where the excess moisture is removed by pneumatically loaded rolls. An adjustable beater spreads the fibre evenly across the feeder sheet. After squeezing, another feeder sheet takes the fibre to a series of spiked rollers which open up the mat before final drying. Each section is equipped with variable-speed drives for the continuous handling of different types of fibre without loss of synchronisation. The fibre is again spread evenly by a beater before entering the first drier.

A slat conveyor traverses the drier, and air heated by steam pipes passes over and through the fibre. The drier is divided into 14 sections, each with a separate circulating fan, and the moisture-laden air is passed to the atmosphere by an extractor fan. The condensate from the steam pipes is used to heat other parts of the building. The fibre then passes to a second drier where final conditioning takes place. This plant can handle 3,500 lb. of dry material per hour. Owing to the considerable risk of fire a drencher system runs the length of both driers.

The dried fibre is pneumatically conveyed either to a cyclone to remove dust or direct to eight preliminary storage bins of which four are being filled and four emptied at any one time. From these bins it is automatically weighed and fed to a centri-blender, again using a pneumatic conveyor, and so to one of 19 storage bins each capable of holding between 8,000 and 12,000 lb. of fibre. Underground ducting, through which the fibre is moved pneumatically, leads to another centri-blender and ultimately to a baling machine. This last will be removed in due course and the fibre fed direct to bunkers over the carpet-production lines. In all, over 2,500 ft. of pneumatic conveyors, some 18 and some 15 in. in diameter, have been employed, including the lines to the four Garnett machines which are fed directly from the second drier.

The whole system is controlled from three panels with mimic diagrams; the first governs the squeezing and drying plant, including the filling of the preliminary storage bins; the second the section up to and including the main storage bins; and the third the final blending.

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REPEATING PROCESS TIMER

Venner Limited, Kingston By-Pass, New Malden, Surrey, have redesigned their synchronous motor-driven process timer to incorporate a push button for repeating a set timing period mechanically. This PT4 process timer, which supersedes the non-repeating type, PT3, repeats the timing period each time the button is pressed. To set the timer, a pointer is turned to the required period and secured by means of a knurled locking ring. On pressing the centre push button, the contacts change over and the set timing period commences. At the end of this time the contacts change back and the timer accurately resets, ready to repeat the period when the push button is again pressed. The push button revolves when the timer is running and incorporates an arrow to indicate the unexpired time. Seven timing ranges are available, from 3 to 60 seconds up to 2 to 40 hours.

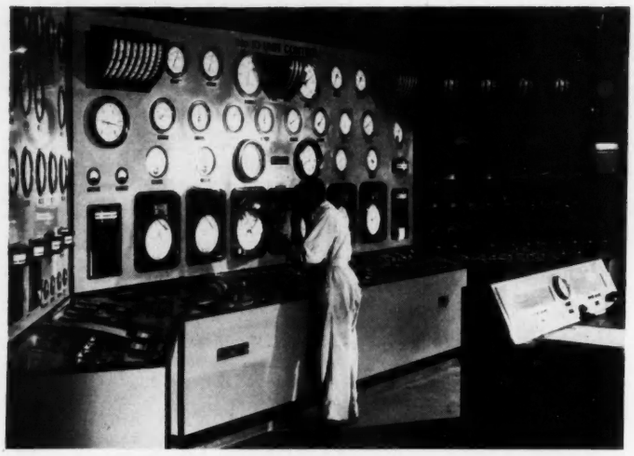


Fig. 1 The new boiler plant for Bowater's paper mills is controlled from a single panel, and not only supplies the turbo-generating set, but also process steam for two mills, although they are 2½ miles apart.

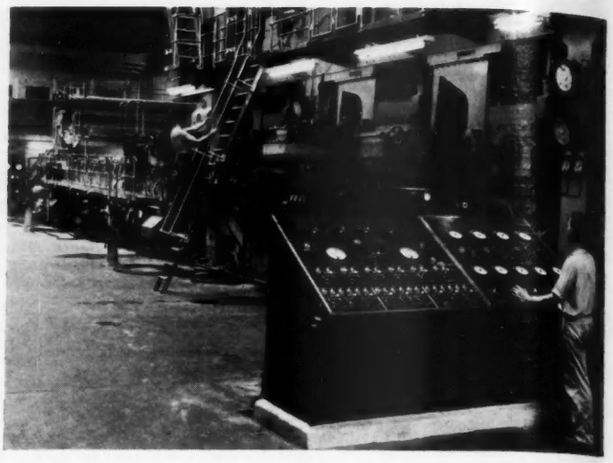


Fig. 2 At the "wet" end of the new paper making machine. Stock is fed on to a wire-mesh belt, where it drains, and then to the presses behind the desk which controls this section.

MORE NEWSPRINT

PAPER PRODUCED AT 2,000 FT. PER MINUTE

The installation of a sixth machine for the manufacture of newsprint at their Kemsley mill was contemplated by the Bowater Paper Corporation, Limited, before the last war. The outbreak of hostilities caused the plan to be held over however, but now the machine, redesigned to include more recent developments, has been put into service. Working at its rated output, it will add about 60,000 tons per annum to the firm's production of newsprint.

To meet the increased demand, new power plant was required, and the opportunity was taken to make this large enough to supply not only the Kemsley mill, but also the one at Sittingbourne (about two and a half miles away), with both electricity and steam. A new boiler house has been built and a Stirling boiler with a continuous rating of 450,000 lb. per hour has been installed. This supplies steam at 925 deg. F. and 1,550 lb. per sq. in. to an English Electric back-pressure turbine which drives a 15MW alternator. Steam leaves the turbine at 575 deg. F. and 370 lb. per sq. in. and is re-heated to 750 deg. F. and 350 lb. per sq. in. (the re-heater being integral with the main boiler) before being passed into the process steam lines. On arrival at Sittingbourne, after passage through an 8 in. diameter main, the conditions are approximately 612 deg. F. and 150 lb. per sq. in. A 20 in. main also runs between the two mills taking steam at 520 deg. F. and 110 lb. per sq. in. from Kemsley and delivering it at approximately 470 deg. F. and 75 lb. per sq. in. at Sittingbourne. The condensate is returned by an 8 in. line. The anticipated full loads of the lines are 60,000 and 170,000 lb. per hour respectively. "Eldorite" moulded calcium silicate has been used for the lagging, with "Asbex" roofing felt as the covering material, except in those sections liable to damage when aluminium sheeting has been fitted. To allow for expansion the lines are laid in a zig-zag manner.

FUEL SAVING

Bringing this new boiler and combined system into commission has meant that 17 old boilers (which have served their useful life) have been made redundant, and can be shut down. It is estimated that this will bring about a minimum saving of 50,000 tons of coal per annum. When the pipeline is in full operation, the 6 MW turbine set at Sittingbourne will be transferred to Kemsley and all the electricity will be generated there. A cable will link the two mills.

The increased capacity of the Kemsley mill has also involved increasing the dock facilities, as almost all the supplies come by water up the river Swale. A new deep water jetty has been constructed at Grovehurst to receive coal from the northern fields, leaving the whole of the old Ridham dock free for handling incoming wood and pulp, and outgoing paper. Two 3½ ton Babcock and Wilcox grab cranes on the jetty unload the coal into two hoppers which feed on to a single conveyor belt having a capacity of 150 tons per hour. This belt is the first of a series which deliver the coal either to the store or direct to the three boiler houses. The coal is spread over the store area by a bulldozer and removed by the same means. Some railborne coal from the Kent collieries is also used, the wagons being emptied by a Strachan and Henshawe 25 ton side-discharge tippler. A conveyor delivers the coal either to the main conveyor system direct, or else to the store. Babcock and Wilcox Limited were responsible for all the coal-handling plant, and also the dust and ash-handling equipment.

The principal feature of the new power plant is the installation of a high-pressure boiler intended to act as a base-load plant superimposed on the existing low-pressure system. The new boiler is of the natural circulation radiant type for pulverised fuel firing and dry ash removal. As mentioned earlier, the reheater is integral with the boiler. Provision has been made in the initial construction for changeover to oil firing if it is feasible to do so at any later date. The maximum continuous rating of the boiler is 450,000 lb. per hour, and with an outlet pressure at the superheater of 1,550 lb. per sq. in. and 925 deg. F. It has a coal consumption of approximately 53,000 lb. per hour at its maximum continuous rating. The boilerhouse is a steel frame structure standing on pre-cast concrete piles designed to meet the requirements of the top-slung type of boiler which produces a very high stanchion loading. The coal from the storage bunkers is fed to four pulverising mills by Simon automatic self-compensating weighing machines, and then to the 16 burners of the inter-tube type which have been arranged for opposed vertical firing.

The combustion control system has pneumatically operated slave cylinders with standby English Electric actuators as control drives for the vanes of the forced draught and induced draught fans; together with the damper control of tempering and primary air supply for the pulverised-fuel mills. For lighting up, there are eight automatic atomising oil burners, supplied by two Hamworthy pumps operating at 200 lb. per sq. in. Associated equipment includes two 48 kW flow type heaters and two 10,000 gallon storage tanks.

The boiler has 34 electrically operated soot blowers, of different types, which are arranged for automatic sequence control from the boiler control panel. Dust is collected by two Howden Centicell units, and is pneumatically transferred from them and from hoppers at other points to one of two Hydrovactors and discharged into the dust sump. It is then pumped to dust ponds. Ash is collected from bottom-discharge hoppers and emptied through hydraulically operated gates into road vehicles.

The entire boiler unit is under the control of the Bailey Meter panel shown in Fig. 1. One feature of the panel is that the position of some of the controls is indicated by illuminated words on an opaque screen instead of by the conventional coloured lights. Both superheater and reheater steam outlet temperatures are automatically controlled by three and two-element systems, respectively. Also mounted on the panel are the remote push-button controls for the pressure-reducing de-superheating plant, which can be operated in parallel with the turbine when the latter is on light loads, or take the full volume of steam when the turbine is not operating.

The English Electric turbine is a single-cylinder machine of 12 stages of impulse blading with two separately anchored steam chests of 7 in. bore and a 16 in. bore exhaust flange. It exhausts steam at 370 lb. per sq. in. gauge, which is then passed back to the reheater. The turbine is coupled directly to a 15 megawatt alternator rotating at 3,000 r.p.m. and generating at a voltage of 6·6 kV. This has both main and pilot exciters. The supervisory panel is mounted at the steam end of the set, and has the speed indicator, shaft-eccentricity and shaft-expansion instruments mounted upon it. The main governor is of the centrifugal type, operated through hydraulic relay gear. An emergency over-speed governor is actuated when the speed is 12½ per cent. above normal by an eccentric ring on the shaft. An Askania regulator controls the back pressure to within plus or minus 5 lb. per sq. in. of the set value. The two Hopkinson de-superheaters each have a capacity of 225,000 lb. per hour and are fitted with electrically operated 7 in. steam and 2½ in. water isolating valves, and 7 to 12 in. Dolly type pressure-reducing valves with their associated electrical regulator. These are followed by spray de-superheater "Hylife" safety valves and hand-operated low pressure isolating valves. In addition to the

remote control push buttons already mentioned in connection with the boiler control panel, there are local control panels for both these units.

MECHANICAL PULP

The supply of logs is seaborne and is delivered to Ridham Dock where they are unloaded and taken by Telfer line to the storage piles. Approximately 250,000 tons of logs, measuring 42 in. long by approximately 6 in. in diameter, can be accommodated in the area at one time. The crabs on the Telfer carry one cord of wood each. When in the stockpile the logs are kept continuously wet, both from the point of view of fire risks and for the subsequent processing. From the pile they are withdrawn on to peg conveyors which take them to the ground-wood mill. In this building, to which the logs are delivered on the upper floor, there are the main mills for reducing the logs to fibre. There are now 36 such mills at Kemsley and the addition of those to supply No. 6 machine was another reason for having to increase the power supply. All the mills are electrically driven. A flume runs the length of the building, into which the logs fall from the conveyor and from which they are extracted by hand-hooks into the hoppers of the grinding machines. Grinding takes place by abrasion under water against either artificial stone wheels or else wheels built up from carborundum sections. The resulting pulp, known as " stock " in the trade, is screened, and the oversized portions, consisting mainly of bark and chips, are extracted and at present are removed to the board mill. At this point the stock consists of about two parts of fibre to 98 of water.

The combined output from the grinders is pumped up to the " deckers " where it is dewatered to make a 3 per cent. solution and passed through various screens. A certain amount of chemical pulp (from both the sulphite and sulphate processes) is also imported, and is mixed with the mechanical pulp in the proportions of 18 to 82. A paddle meter regulates the flow, and the mixture passes into the main stock chest. At this point it is diluted with more water to form a ½ per cent. solution and then passes through refiners and more screens, the oversized matter and rubbish being removed. Pumps then take the stock up to the machine flow box. The latter is maintained under air pressure, to increase the rate of flow of the stock on to the wire mesh of the machine so that the designed production rate can be achieved.

From the stock outlet, the mixture of water and fibre is carried by an endless phosphor-bronze woven-wire belt and during its travel the water drains through the open mesh into the pits below and is re-circulated. For the first part of the distance, the wire-mesh belt is supported on rollers and free drainage occurs; it then passes over a series of vacuum boxes which remove more of the water, and finally over a suction roll. By this time, a large proportion of the water has been removed and the wet mat of the fibre remains. The vacuum boxes reciprocate slowly in a direction at right angles to the travel of the belt, so that the whole area can be covered evenly. The heads of these can be seen in Fig. 2, which shows the wet end of the new No. 6 machine. The wet mat of paper is removed from the wire mesh belt by suction, which draws it on to a woollen felt, carried round a suction pick-up roll. The basic purpose of this roll is to prevent the very weak web of paper being stretched and broken at this critical point in its manufacture. From the pick-up roll, the sheet of paper now adhering to the under-side of the felt is transferred, again by means of vacuum, on to the upper side of another belt, which takes it through the first press. It subsequently passes through two suction presses, and then begins its passage through the drying machine. After pressing, the paper, on its felt webbing, passes over a series of rolls which are steam heated, until it reaches the correct degree of dryness, at the far end. From the rolls it passes through a calender, of which the rolls are made of chilled iron, and it is then reeled up on a pneumatically controlled machine. This reel can be seen in the right-hand mid-distance of Fig. 3.

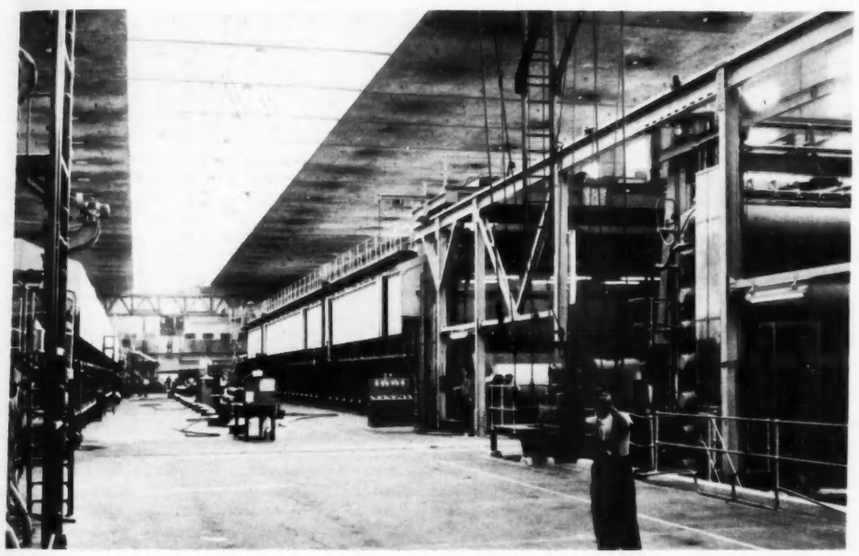


Fig. 3 Looking along the new machine from the " dry " end can be seen the super calender, the first Beloit reel and the drying section in which the paper is carried over a series of heated rolls. On the left is an earlier machine.

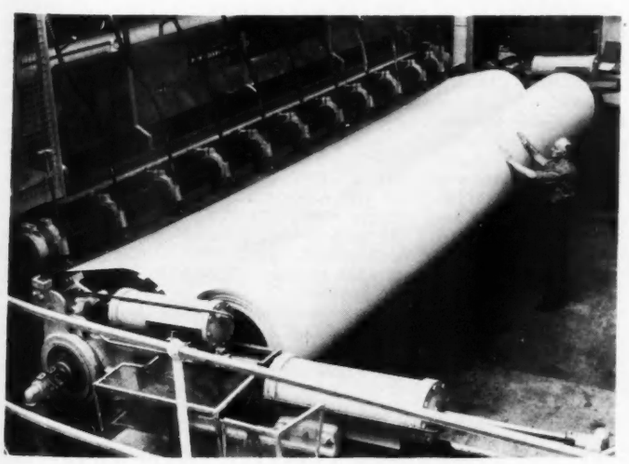


Fig. 4 The super calender passes the paper to the second Beloit reel which has pneumatic cylinders for the operation of reel changing. Finished reels may be 88 in. in diameter and weigh 17 tons.

MACHINE IMPROVEMENTS

The length of the whole machine, including the super calender and the winders, is over 500 ft. The sheet of paper produced is 22½ ft. wide and the running speed at normal full production is 2,000 ft. per min. This is the highest speed of any of the Kemsley machines, but the No. 5 machine, which runs parallel to the No. 6, produces a slightly wider sheet. The main difference between the two machines (No. 5 was installed about 20 years ago) are the new layout for the screens; the use of compressed air in the feed box; the suction pick-up roll and press arrangement; and the reel which can take up to 88 in. in diameter in place of the 42 in. of the earlier machine. In addition, the overhead crane system for moving the reels has been improved to cut the time of handling. The winder speed has been doubled, and the drive for the whole machine is under electronic control. The whole of the design, planning and erection of the No. 6 machine and its ancillary equipment was carried out by the engineering division of the Bowater Corporation and the staff of the Kemsley division.

The wire-mesh belt which carries the stock over the first part, is supported on 16 table rolls each of 16 in. diameter. The designed length of passage is 115 ft. 6¼ in., with a fall of 12 in. from the top of the breast roll to the top of the suction couch roll. There are seven vacuum boxes in all, four being arranged before the Dandy roll position and three after. The boxes are 12 in. wide and are oscillated by a 5 h.p. geared motor. At the moment, no Dandy roll has been fitted, but provision has been left for one at some future date. The suction couch roll is a Millspaugh 44½ in. diameter non-cantilever type. The couch and forward wire roll are driven through a single independent gearbox designed to transmit an input of 550 h.p. Provision has also been made to carry a 24 in. diameter top couch roll with pneumatically operated lifting gear.

The vacuum pick-up roll of the press section is rubber covered and 34 in. in diameter. A quick-release gear is incorporated to remove the roll from the wire in the event of a serious break at the presses. The top rolls of the three suction presses and of the wringer press are of granite, 33 in. in diameter. Pneumatic power is used to control the nip. The press section of the machine is immediately to the right of the control desk in Fig. 2.

In the drying section of the machine, there are 53 drying cylinders, six felt dryers, one leading cylinder and one cooling cylinder, arranged in three sections. The drying cylinders and felt dryers are each 60 in. outside diameter and 286 in. along the face, the rear side centres being extended for receiving the gear wheels and

steam nozzles. The cooling cylinder is similar, but the front centre has a water nozzle with plain outlet at the rear. The leading cylinder (42 in. outside diameter and 286 in. face) is of similar construction to the other cylinders. The drive of the cylinders is from three indrive pinion shafts and through gear-wheels and intergear-wheels. This section forms the greater part of the length of the machine, as may be seen in Fig. 3 which is taken from the " dry " end.

REELING

After drying, the paper passes through a finishing calender, which is designed to take up to eight chilled-iron rolls. All rolls, with the exception of the bottom one, are bored for steam heating. The reeling machine to which the paper now passes can be seen in the centre right of Fig. 3. This is of the Beloit type. The reel drum is 36 in. in diameter and 280 in. face, the rear end being extended to take the drive. The reel shells are 22 in. in diameter and 289½ in. face, and are balanced for all speeds up to 6,000 ft. per minute. When the reel is completely wound, the transfer to a new mandrel can be made without stopping the machine. This is effected by two pneumatic cylinders operating on the transfer arms, and main air cylinders operating on the main support rail. The completed reel is lifted by a 20 ton overhead crane, which also has auxiliary hooks with a capacity of three tons. This lifts the reel, which may weigh as much as 12 to 15 tons, over to the super calender machine which follows next in sequence. This is designed to accommodate ten rolls, and is suitable for a maximum operating speed of 2,500 ft. per minute, and for a maximum nip pressure at the bottom roll of 1,000 lb. per in. of roll face. Maximum reel diameter which can be accommodated in the unwinding stand is 88 in. In front of the unwind stand, there is a travelling cross platform which acts as a follow-up on the reel as the paper unwinds, maintaining a constant distance from the diminishing reel. It is operated by electro-hydraulic and photocell equipment. The Beloit reel at the super calender is similar to that fitted at the machine calender, and is shown in Fig. 4.

The winder, made by the Cameron Machine Company, is designed for an operating speed of 5,000 ft. per minute for a 270 in. trim width, producing finished reels 42 in. in diameter. The machine has a twin-drum drive and a counterbalanced riding roll. An automatic pressure distributor, with independent shock absorbers at each end, provides automatic self alignment of the riding roll from zero to one inch. The slitter units have 9 in. diameter cutter wheels, the cutter mounting bar being hydraulically operated for rapid manual traversal of the cutter holders. The roll ejector has safety locks to prevent operation when the winder is running.

In the basement below the machine house is a Grewin dry " broke " handling plant, which is capable of handling up to a maximum of 12½ tons of " broke " (that is, paper scrapped for any reasons from the manufacturing machines) per hour. The plant is divided into three independent units, one each under the finishing calender, the super calender and the winder. Scrap paper is returned for pulping down and re-circulated into the stock. The complete plant is almost entirely automatic in operation. Also in the basement is the vacuum plant for extracting the water from the stock as it passes through the machine, and also for transferring the mat of paper from one belt to another. The plant was supplied by Sulzer Brothers and comprises two radial turbo blowers under an automatic control system.

ELECTRONIC CONTROLS

The drive to the paper machine is through 13 B.T.H. motors each driving a separate section and with powers varying from 40 to 550 h.p. The speed range is designed to be from 900 to 2,300 ft. per minute. Each motor is supplied from a separate generator so that its speed can be varied relatively to the others. Two 1,100 h.p. 616 kV synchronous motors drive two multi-generator sets which supply the motors. There is an overall control to raise or lower the speed of the mill as a whole, as well as the individual controls for the separate motors which allow for draw or stretch in the paper as it is formed.

Control is effected by tachometers and electronic amplifiers feeding alternating-current driven thyratrons connected to centre-tapped transformers. These act on the field windings of the generators and so vary the voltage supplied to the motors. From the motors the drive to the machine is through B.T.H. gearboxes and Wellman Bibby couplings. The system was designed by B.T.H. and is somewhat similar to those used at Velindre and Trostre rolling mills, though in this case electronic amplifiers are used. Control of the motor speed is within 0·1 per cent. and the operator's controls include an " off-crawl-run " switch, a draw rheostat and a slack take-up button. There are additional drives at the wet end, and a separate drive for the super calender, employing a Ward Leonard control. The latter also includes a 60 h.p. braking generator for the unwinding reel, and a 90 h.p. motor for the wind-up reel, both of which have automatic constant tension control effected by electrical means. The mass of the reels (about 17 tons) presents a problem in acceleration and deceleration, and this was overcome by using B.T.H. of Amplidynes which have enabled a system to be produced that can accelerate or decelerate reels of any diameter between 22 and 88 in. without adjustment of the tension control. Re-generative braking is also used on the winder drive which has much the same problems as the super calender. Friction brakes are also fitted to assist in stopping the unwinding reel.

SURVEY SHIP DESIGNED AND BUILT FOR THE FALKLAND ISLANDS

R.R.S. JOHN BISCOE LEAVES FOR THE ANTARCTIC

Carrying vital supplies, equipment, and relief scientists and technicians for the permanent bases of the Falkland Islands Dependencies Survey, which are located along the cost of Graham Land and on various groups of islands in the South Polar region, the new Royal Research Ship John Biscoe, specially designed for the rigorous journey, with " ice-breaker " bows and a strengthened hull, left Southampton on her maiden voyage to the Antarctic on Monday November 26, last.

Designed by Graham and Woolnough, Liverpool, for the Falkland Islands Dependencies Survey and built by Fleming and Ferguson, Limited, Paisley, the John Biscoe is classed with Lloyd's Register of Shipping 100 A1, with the special notation " Strengthened for Navigation in Ice."

The principal particulars are: length overall, 220 ft.; length between perpendiculars, 200 ft.; breadth moulded, 40 ft.; depth moulded, 20 ft.; gross tonnage, 1,584 tons; and service speed, 12 knots. She carries a complement of 33 officers and crew, and accommodation is provided for 34 scientists.

A feature of the hull plating is the use of Coltuf 28 (a product of Colvilles Limited,) a low-temperature high-impact steel with a high notch ductility, capable of withstanding the arduous service conditions encountered when the vessel is operating at sub-zero temperatures. In addition to the icebreaker bows, intermediate framing is used extensively throughout the ship. Heavy fins and an ice knife are fitted as an integral part of the hull to give maximum protection to the propeller and rudder.

The John Biscoe, shown in the accompanying illustration, has a forecastle deck with a combined bridge and poop deck fitted immediately abaft the cargo hatch. Superimposed on the bridge deck is the boat deck, and directly above, the navigating bridge.

The foremast is fitted with two 10 ton derricks for servicing the forward cargo hold and handling the large scow and motor boat, chocked on the upper deck, which are used in transporting stores to the bases, when the vessel is anchored off-shore. The mainmast is fitted with a 3 ton derrick for servicing, through a trunked hatchway, the store rooms on the lower deck and the aft cargo hold. The Talurit system of clamping, as distinct from wire-rope splicing, is freely adopted. Two 5 ton electric winches are provided for working the forward derricks and a 3 ton electric winch for working the aft derrick.

A comprehensive outfit of mooring equipment is installed in the John Biscoe. The ground tackle includes one steam anchor weighing 3¼ cwt., together with three stockless bower anchors, weighing 26¾ cwt. each, and 300 fathoms of Tayco 1½ in. high-tensile steel cable, joined in 15 fathom lengths with Kenter shackles. A 6 ton electric windlass located on the forecastle deck and a 4 ton electric capstan on the poop deck, both supplied by Stothert and Pitt, Limited, provide the necessary facilities for anchoring and berthing.

ACCOMMODATION

The Captain's suite, situated on the boat deck, immediately adjoining the Governor's stateroom, comprises dayroom, bedroom and private bathroom. The officers' and engineers' single rooms are located on the bridge deck, at the forward end of which is a combined wardroom and dining saloon extending across the ship for the full width of the deckhouse. The engineers have a separate messroom for their own use. On the main deck are the two-berth cabins, dining saloon and recreation room of the scientific personnel. Immediately abaft are the petty officers' and crew's cabins and crew's recreation room.

A large galley, with electrically-operated equipment, caters for the ship's company. Adjoining the galley is the main pantry and pantry store. In addition to the main pantry, there are a number of pantries throughout the ship to provide service to the various public rooms. The laundry, on the main deck aft, includes in its equipment an electric washing machine and hydro extractor. The refrigerated chambers, on the lower deck aft, include a cold store, meat room, vegetable room and handing room.

To obviate the extremes of temperature experienced in service, the weather boundaries of all accommodation are insulated with resin-bonded glass fibre to a density of 4¼ lb. per cub. ft., supported by 1 in. thick Onazote slabs faced with ¼ in. plywood, with a centre core of 34 s.w.g. aluminium.

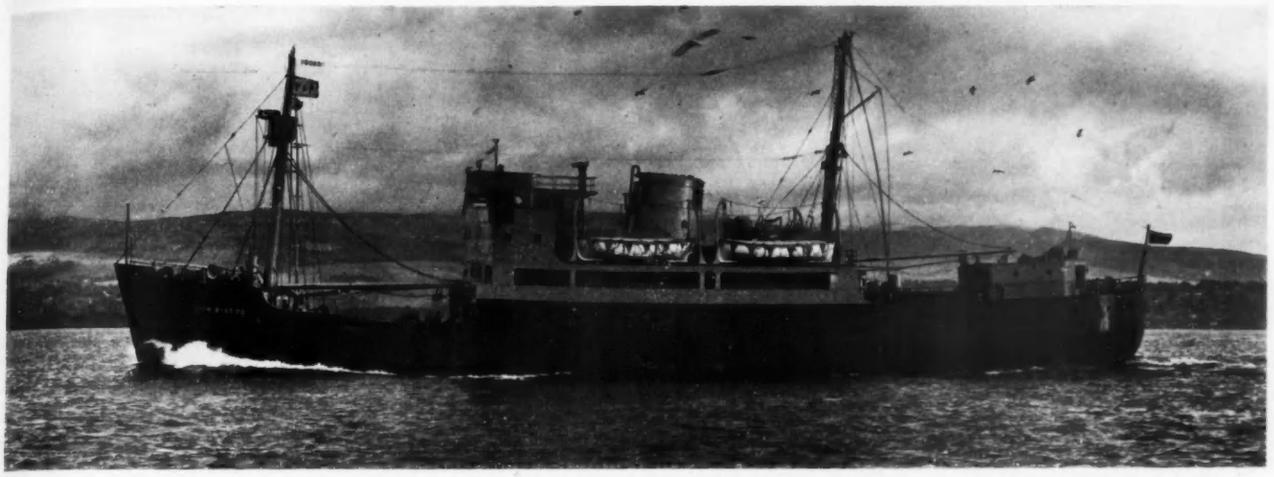
STEERING AND NAVIGATING

Electro-hydraulic steering gear by Brown Brothers and Company, Limited, Edinburgh, allow an uplift on the rudder of 4 in., so that, in the event of the rudder grounding and damaging the stern with consequent distortion of the deck under the steering gear, the gear will continue to function so long as the rudder is not jammed.

Every care has been taken to ensure that the latest scientific aids to navigation have been placed at the disposal of the deck officers. Kent Clear-View screens are provided, and, in addition, hot air is funnelled to the windows in the wheelhouse from spigots led from trunking along the wheelhouse front. A Sperry Gyro Compass Mark E.I. is installed, with repeaters on the

navigating bridge wings and in the steering gear compartment.

The vessel has, of course, a wide range of communication equipment and radio aids to navigation. This installation includes the latest Globespan transmitter, with radio-telephone facilities, and Atalanta receivers for medium and high-frequency communications. A Reliance transmitter, with an Alert guard receiver and Autokey device, is fitted for emergency use. Radio aids to navigation comprise a Decca Marine Radar 45 with receiver unit and display unit, located in the wheelhouse. Echo-sounding units, recording depths, both shallow and deep, and a sea temperature thermograph with indicator dial in the chartroom, are provided.



The new survey vessel for the Falkland Islands Dependencies, R.R.S. John Biscoe, left Southampton on Monday, November 26, on her maiden voyage to the Antarctic, carrying relief staff and supplies for the permanent bases.

A comprehensive sound-reproducing and order system is also installed. Two 10 in. diameter searchlights are located on the navigating bridge, one on each wing.

PROPULSION AND GENERATING MACHINERY

The main propulsion machinery comprises two Diesel-driven direct-current generating sets normally connected at full power in series with one double-armature motor directly coupled to a single line of propeller shafting. The propulsion motor is capable of developing 1,350/1,450 s.h.p. at 175/180 r.p.m., and to permit of a wide range of ship's speed. Control of the motor is by the Ward Leonard method to half speed, by engine control up to normal full speed and by shunt-field control to give exceptionally low propeller speed for emergency use in heavy ice.

The entire propulsion electrical machinery with control and auxiliary generators are by the General Electric Company, Limited, Witton, and the Diesel machinery by the National Gas and Oil Engine Company, Limited, Ashton-under-Lyne. The electrical installation has been carried out by J. Charters, Glasgow.

Each main generator is capable of an output of 295/640 kW when running at 260/600 r.p.m. and each auxiliary generator of an output of 200 kW when running at 550/600 r.p.m. The auxiliary generators supply power for the engine room and ship's auxiliaries, lighting, ventilation and other services throughout the ship. A combined Diesel-driven generator and air compressor for emergency duties is situated in a compartment outside the engine room. This set is self-contained.

The main and auxiliary generator engines have water spaces provided under the main bearings for oil-cooling purposes, the cooling water being supplied by independent sea-water pumps. After leaving the engine bedplate this cooling water is led to the heat exchangers and utilised for extracting surplus heat from the fresh-water cooling circuit. It is finally discharged overboard or may be led back as warm water to the sea suction compartments, if necessary, when the ship is in Antarctic waters.

The fresh water cooling is a closed thermostatically-controlled system, the water for the main engines being supplied by independent pumps and for the auxiliary engines either by independent pumps or the pumps built integrally with the engine. For normal running, the fresh water is circulated through the engine and discharged to, or bypassing, the heat exchangers.

When the vessel is operating in Antarctic conditions, provision is made for the cooling-water outlets of both main and auxiliary engines to be led to Thermotanks through a steam-operated calorifier, thermostatically controlled, which maintains the water at a temperature of 150 deg. F. approximately. This hot water passing through the Thermotanks is utilised in raising the temperature of air for the accommodation. The water returns to the suction side of the fresh-water cooling pumps at about 130 deg. F. for re-circulation to the engines. Provision is also made for circulating warm water through the main engine jackets from either of the auxiliary engines in use, for maintaining a suitable temperature before starting.

Each main and auxiliary exhaust is led to a combined silencer and exhaust heat boiler for supplying steam at 49 lb. per sq. in. to calorifiers, radiators, etc. If required, the steam supply is maintained by an oil-fired vertical boiler of "Spanner" type and also by an electrically-operated boiler.

Drysdale Rotary Centrex pumps each of 100 tons per hour capacity are provided for the fresh and sea-water systems of the main and auxiliary engines and a similar pump is provided for bilge and general service.

The fire and wash-deck service is supplied by the general service pump and also by one of the sea-water cooling pumps which are interconnected. An additional bilge pump of 50 tons per hour is provided for bilge duties only.

The lubricating oil system for the main engines is operated by an independent pump for each engine drawing oil from a drain tank integral with the engine bedplate and situated under the sump. Two Alfa-Laval purifiers can draw from the engine drain tank directly or from a dirty-oil storage tank and can discharge directly to the engine or to a purified-oil storage tank. Reserve lubricating oil is carried in two large storage tanks on the engine room casing. The auxiliary engines have a self-contained lubricating oil system, the pumps being integral with the engine.

The fuel oil is stored in deep and double-bottom tanks in the engine room. Two tanks are utilised as settling tanks into which the overflow from all other deep tanks is taken. The settling tanks are fitted with high and low level alarms which give warning in the engine room and, in the case of the high-level alarm, to the filling station on deck. Two daily-service fuel-oil tanks for main and auxiliary engines and one for the oil-fired boiler are fitted in the machinery space.

Compressed air by two Reavell motor-driven compressors, delivering air at 350 lb. per sq. in., is stored in two air receivers of 40 cub. ft. capacity and two of 11 cub. ft. capacity each.

The main fire-extinguishing equipment consists of a complete carbon dioxide system with nozzles at various positions in the engine room, the carbon dioxide bottles being accommodated in a compartment outside the engine room.

To ensure quiet running of the engines, acoustic hoods are fitted over the cylinder heads and the engines are resiliently mounted. Acoustic insulation is provided to all the ship's structural surfaces contiguous with the engine room, to prevent the transmission of machinery sounds to any part of the accommodation or the wheelhouse. A well-equipped workshop is provided at the aft end of the engine room, adjacent to the engineers' store, complete with motor-driven lathe, drilling machine and grinder.

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IRON AND STEEL INSTITUTE

At the autumn general meeting of the Iron and Steel Institute, held in London on November 21 and 22, the President, Dr. H. H. Burton, C.B.E., proposed, on behalf of the Council, that Mr. Arnold H. Ingen Housz, of the Royal Netherlands Steelworks, and an honorary vice-president of the Institute, be nominated for election as President, to take office at the annual general meeting of the Institute, to be held in London on May 22 and 23, 1957, and to serve for one year. Dr. Burton added that the last time that the Presidency had been occupied by a metallurgist from overseas was in the years 1918 to 1920, when Mr. C. P. Eugène Schneider had served in that capacity.

Other announcements made were that the three vice-presidents due to retire at the annual general meeting in May, 1957, were Mr. C. R. Wheeler, C.B.E., Mr. D. F. Campbell and Mr. G. H. Latham. Similarly, the five members of Council due to retire comprised Mr. S. Thomson, Mr. E. T. Judge, Mr. E. J. Pode, Mr. B. Chetwynd Talbot, and Mr. W. L. James. All eight were eligible for re-election.

The final announcements were that a special meeting would be held in Sheffield during the week beginning July 8, 1957, and that next year's autumn general meeting would take place in London on November 20 and 21.

Book Reviews

MASTER AND MAN

Work and Authority in Industry: Ideologies of Management in the Course of Industrialization. By REINHARD BENDIX. *John Wiley and Sons, Incorporated*, 440 *Fourth-avenue, New York* 16, *N.Y., U.S.A.* (7.50 dols.); and *Chapman and Hall, Limited*, 37 *Essex-street, London, W.C.*2. (60*s.*)

Profound changes have taken place during this century in the professed attitudes of employers and managers to workers and these are within the recollection of many still in industry. What is not generally realised is that these changes are merely the latest to form part of an ideology of industrial management which has been developing since the Industrial Revolution and which, although it shows common features arising from common technological developments in different countries, nevertheless differs according to the particular social and political soil from which it sprang.

Modern large-scale industry, with its need for the disciplined activity of large numbers of literate workers, has given to the perennial conflict between rulers and ruled a new form to the solution of which very different answers are attempted in countries with democratic and with totalitarian forms of government. In the former to-day emphasis is all on personnel management, human relations and the arts of communication; in the latter, reliance is placed on the role of the Party in stimulating the masses to co-operation and maximum effort. In both systems the reality often belies the expressed intention, and conflict, either open or suppressed, results.

Professor Bendix's learned and absorbing study of managerial ideologies at four different times and places makes a major contribution to the understanding of this endemic conflict of our time. He examines from their own statements and that of their apologists the attitudes that employers and managers have adopted to their workers in England and Tsarist Russia during the Nineteenth Century, and in the United States and Eastern Germany to-day. It is inherent in the choice of subjects that the discussion of the British and American ideas gives an impression of ill-formed groping after some philosophy of management which would reconcile the crude desire for absolute authority with the facts of growing democratisation of society and the increasing power of the trade unions, while that of the Tsarist and Communist regimes is more concerned with the conflicts arising out of the attempts to apply at all managerial levels the policies of strongly centralised governments which alone have had the right to expressed opinions.

In England the traditional relationship between the ruling class and the poor had been one of paternalistic responsibility. It conflicted with the demands of the rising business class who needed a mobile labour force subject to the discipline of purely economic considerations. Industrialisation, by destroying the way of life of English peasants and workers, roused the people to revolt in an attempt to recover their traditional position and prevent their increasing social isolation. The Eighteenth Century had already seen the beginning of a new attitude to poverty, attributing it not to misfortune but to vice, and this led to an attempt to inculcate in the poor, religious devotion, morals and discipline. The education of the workers led, however, to the growth of political consciousness and the need to produce a philosophy of work which could appeal to the masses. The hopeful gospels of Samuel Smiles, which promised success to all who worked diligently, replaced the Calvanistic outlook and softened the brutal authoritarianism of the early factory owners.

In Tsarist Russia relationships were dominated by the subordination of all classes to the Tsar and by the traditional rights of the landowning class over their serfs. Many industrial enterprises grew up on the estates of aristocrats and were manned by their serfs; other were established by the Tsars themselves. The fact that the Tsars expected the serfs, and later the factory workers, to look to them for their ultimate protection and yet, for economic reasons, gave to the landowners and factory managers, autocratic rights over those they employed, led to a dichotomy in authority which has been inherited by their Communist successors. To-day, in the Communist states, although the manager of an enterprise has full authority and responsibility for carrying out the plan allocated to him, he is " assisted " in this task by a hierarchy of party officials whose business it is to ensure that the will of the leaders of the party prevails, even as it changes from day to day. An uneasy balance is thus kept between the needs of the plan and the pressures of reality, including those of the workers themselves.

The early American capitalists did not suffer from a traditional social climate. They developed a militant philosophy of personal success, based on Smiles' and on Herbert Spencer's ideas of the struggle for existence; but this individualistic approach was challenged by the trade unions, who forced American employers to attempt to develop a collective approach to the labour problem. At first this took the form of the " open shop " campaign, designed to safeguard the absolute authority of the employer, but the increasing complexity of industrial organisations led to the development of scientific management and, later on, of industrial psychology to provide a guide on the use of authority. Gradually the virtues of co-operation and of satisfaction in work began to take the place of success in the exhortation of workers, and in the 1920's and 1930's these attributes became the subject of psychological inquiry; first as to their relationship to the worker's aptitudes, and then to his attitudes. With the increasing bureaucratisation of industry the conception of the manager also changed and new qualities were admired in place of the aggressive individualism of the early enterpreneurs. Here the major influence was the work of Elton Mayo, who stressed the value of emotional balance and control and of adaptability within the organisation.

Although these new ideas receive ample lip service from the younger executives in the United States, and particularly the personnel and public relations specialists, their superiors often act and speak as if they believed that the old-fashioned qualities are still important even in the large-scale corporation. If they support the ideological and other gimmicks of the human relations experts, it is because they have found that, as enterprises grow larger and the traditional work relationships are codified by rules, job and work studies and other necessary techniques of large-scale industry, the workers tend to respond by doing only so much as they are compelled to do by whatever method of control of their work is employed. Although this problem of the substitution of obedience to rules for observance of traditions appears as a problem of modern industry, it is in fact as old as civilisation itself. In Volume II of *Science and Civilisation in China*, Dr. Joseph Needham quotes a Confucian sage: " The ancient kings, who weighed matters very carefully before establishing ordinances, did not write their system of punishments . . . But since all crimes cannot be prevented, they set up the barrier of self-righteousness, bound the people by administrative ordinances, treated them according to just usage, guarded them with good faith and surrounded them with benevolence . . . But when the people know that there are laws regulating punishments, they have no respectful fear of authority. A litigious spirit awakes, invoking the letter of the law and trusting that evil actions will not fall under its provisions." Whether a new tradition of work will grow up, taking the place of supervision and control, is one of the most interesting questions of future social history.

ADULTS INTO CITIZENS

A Design for Democracy. Published for the Adult Education Association of the U.S.A., the Canadian Association for Adult Education and the National Institute of Adult Education, Great Britain, by *Max Parrish and Company, Limited*, 55 *Queen Anne-street, London, W.*1. (15*s.*)

It is often forgotten how new a system of universal education is in this country. Elementary education dates only from the later years of the last century, while universal secondary education is a post-war development which has still to show its full potentialities. Readers of Thomas Hardy's moving novel, *Jude the Obscure*, will recall the bitterness with which its hero found himself shut out from the knowledge which was taught within the college walls which he repaired.

It is not surprising, therefore, that the demand for the right to be educated should have been associated with the social and political ferment of the last hundred and fifty years and with the institutions thrown up by that ferment: the nonconformist churches, the Co-operative movement and the trade unions. In the absence of other provision, they at first set out to give adult working men and women the elementary instruction which they lacked; but as the State gradually assumed the function of elementary schooling for children, the voluntary bodies moved on to a variety of more advanced forms.

Among the welter of new ideas generated by the first World War, those concerning education played a prominent part, and one of their most important fruits was the 1919 report of the Committee on Adult Education, one of the sectional committees of the Ministry of Reconstruction whose demise it survived. It is a shortened version of this historic document which has here been reprinted with an introduction and an assessment of subsequent development by Professor R. D. Waller.

The report was a document of extraordinary breadth and prescience and, although unduly optimistic in places, much of what it proposed has been achieved. It regarded education as a social function designed to contribute to good citizenship and did not hesitate to recommend that the State should support any genuine educational effort, even if it were the work of a body whose main object was the furthering of a particular point of view.

The authors of the report forestalled some of the arguments, now much heard, about the place of science in relation to other studies, recognising the desirability of encouraging a wider diffusion of scientific knowledge and of the scientific habit of mind. They realised that technical education was capable of being treated in a broad and humanistic spirit but that, to achieve this, it must include an increasing content of pure science and non-vocational subjects. It would also have to be conducted in institutions where the student had the opportunity to mix with others working in different fields.

To-day the opportunity for everyone to get full-time higher education is infinitely greater than when this report was written and the field of adult education has changed. New forms have come into being and the advent of motor transport has brought them to the village as well as to the town. Further advances may have to await the impetus that will be given to the desire for education by the implementation of the clauses of the 1944 Education Act designed to raise the school leaving age to 16 and to make one-day release to a continuation school compulsory.

NEW BOOKS

Some of the books noticed here are selected for extended review in ENGINEERING.

Automation in Theory and Practice. A Course of Lectures Organised by E. M. HUGH-JONES. *Basil Blackwell, 49 Broad-street, Oxford.* (12*s.* 6*d.*)

These lectures were originally given at Oxford during the Michaelmas term 1955 under the auspices of the Faculty of Social Studies. The audience was therefore largely undergraduates who were in the main students of economics. The six lectures following the introduction which gave definitions, historical backgrounds and general objects, dealt with: the scientific basis; automation in production; the trade union approach; administrative application; social aspects; and the present position. A list is given of suggestions for further reading.

Performance Criteria of Gas-Turbine Combustion Chambers. By D. B. SPALDING. *Bunhill Publications, Limited, 12 Bloomsbury-square, London, W.C.*1. (4*s.*)

This monograph was first published as an article in *Aircraft Engineering*, April and May, 1956. It sets out to give the designer of a gas turbine a basis for selecting the design of the combustion chamber. Combustion chamber test data are expressed in terms of dimensionless criteria which are plotted in various ways to enable the various chamber designs to be compared. The treatment deals implicitly with the conditions which satisfactory model tests must fulfil. An idealised model of a gas-turbine combustion chamber is introduced in the light of which the effects of changes in the overall fuel-air ratio can be explained more satisfactorily than when conditions in the flame tube are supposed homogeneous.

Application of Spring Strips to Instrument Design. Notes on Applied Science No. 15. Published for the Department of Scientific and Industrial Research by *H.M. Stationery Office, Kingsway, London, W.C.*2. (2*s.*)

This note is intended to provide designers with information on various applications of spring strips in instruments. It covers single spring-strip pivots, cross-spring pivots, parallel motion with spring strips, conversion of linear to angular motion, the use of buckling strips and twisted spring strips in instrument mechanisms, indicating mechanisms based on the twisting and bending of strips, miscellaneous applications, and methods of attaching spring strips to instrument mechanism.

The Mechanical Testing and Inspection of Engineering Materials. By J. H. LAMBLE. *Cleaver-Hume Press, Limited, 31 Wright's-lane, Kensington, London, W.*8. (3*s.* 6*d.*)

This monograph forms Chapter 20 of Modern Workshop Technology, Part 1: Materials and Processes, edited by Professor H. Wright Baker. It covers the routine testing for tensile strength, impact and hardness, transverse and bend tests; non-routine tests such as torsion and shear tests, and fatigue testing, tests at elevated temperatures, non-destructive and exploratory test methods.

Plastics Engineering. By F. T. BARWELL. *Cleaver-Hume Press, Limited, 31 Wright's-lane, Kensington, London, W.*8. (3*s.* 6*d.*)

This monograph forms Chapter 19 of Modern Workshop Technology, Part 1: Materials and Processes, edited by Professor H. Wright Baker. After defining plastics and describing some important polymers, the author discusses various moulding methods—compression and transfer moulding, injection moulding, extrusion, forming thermoplastic sheet, casting, welding and heat-sealing. The next section is concerned with reinforced plastics—the manufacture, strength, and processing of laminated sheet, and the use of resin-wood combinations. This is followed by the properties and testing of plastics—mechanical strength, electrical properties, and serviceability. The use of plastics as engineering materials is then discussed and possible fields of application are considered.

Axial and Centrifugal Compressor Design for Aircraft Engines. By NORMAN C. BREDDY. *The Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey.* (3*s.*)

This volume comprises two separate notes on the design of axial and centrifugal compressors. On axial compressor design, the author briefly considers aerofoil theory and cascade performance, work done per stage, reaction, vortex flow, stage performance and pressure rise compressibility effects, the use of generalised performance curves and the evaluation of overall performance. On centrifugal compressors, he covers the work done during compression and the pressure rise, and deduces the adiabatic efficiency. After dealing with diffuser performance he discusses compressibility effects at the impeller intake, in the impeller passages and in the diffuser. The whole treatment does not demand an advanced standard of mathematical knowledge.

Frequency Modulation Receivers. By J. D. JONES. *Heywood and Company, Limited, Drury House, Russell-street, London, W.C.*2. (21*s.*)

The first chapter of this book deals with the reasons for using frequency modulation for high-quality broadcasts. Then follow discussions on the various sections of F.M. receivers which are covered in detail. The final chapter gathers all the sections together to make a complete receiver circuit.

Pulse and Digital Circuits. By JACOB MILLMAN and HERBERT TAUB. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (12.50 dols.); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.*4. (94*s.*)

This book sets out to give a thorough theoretical understanding of pulse and digital circuits and techniques; practical details are not excluded, however. Worked examples are given and at the end are more than 400 "homework" problems. Chapter headings include: linear wave shaping; multivibrators; time base generators; transmission gates; and particular applications of transistors.

Earth Satellites as Research Vehicles. Published under the auspices of the *Journal of the Franklin Institute, 20th and the Parkway, Philadelphia 3, Pennsylvania, U.S.A.* (2.50 dols.)

This is a report of a symposium held in April this year at the Franklin Institute. The papers published here comprise "The International Geophysical Year," "Earth Satellite Program," "The Moon Rocket," "Astronautical and Space-Medical Research with Automatic Satellites," "Astrophysical Research with an Artificial Satellite," "The Effect of the Earth's Oblateness and Atmosphere on a Satellite Orbit," "Astro—an Artificial Celestial Navigation System," and "Recovery of Data in Physical Form."

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Tube Manufacturing Practice and Specifications. ACCLES AND POLLOCK LTD., Oldbury, Birmingham. Revised and enlarged edition of the firm's publication "Practice and Specifications," under the new name of "Tube Manufacturing Practice and Specifications." The various sections are concerned with such matters as the range of products covered, tolerances, notes on manufacturing practice, analyses and properties, British specifications, American specifications, notes on stainless steel, technical data on non-ferrous metals, the relative corrodibility of metals, data on tapering rolls and Dayton tools and conversion tables and information for the use of engineers. Cloth-bound publication of 96 pages.

Non-Destructive Testing. SOLUS-SCHALL LTD., 15-18 Clipstone-street, London, W.1. Descriptions of the Magnaflux and Magnaglo methods of inspecting magnetic materials by means of ferro-magnetic and fluorescent magnetic particles, respectively; the Zyglo method for the inspection of non-magnetic solids by fluorescent penetrating media; the Statiflux powder method for locating defects in ceramics, glass, china and plastics; the Partek filtered-particle inspection method for ceramics and porous solids; and the Stresscoat sprayed-on brittle coating for identifying concentrations of stress in components and assemblies. Illustrated booklet.

Aluminium Alloys. HIGH DUTY ALLOYS LTD., Slough, Buckinghamshire. Tabulated data on the characteristics, compositions and mechanical properties of the firm's Hiduminium wrought and cast alloys, to which are added notes on welding, brazing, soldering, forming, machining and other pre-service treatments; information on hot-rolled plates, cold-rolled sheets and other rolled products; and data on fabrication. Tables of tolerances and gauge-conversions and lists of weights of circles and standard-size sheets are also included. Flat-opening publication of 143 pages.

Paint Sprayers. MIRACLE SPRAYERS (DISTRIBUTORS) LTD., 64A Kings-road, London, S.W.3. Explanation of the principle of the mist-free Sicmo-Bendix paint-spraying gun. This states that the projected paint is enveloped by an outer layer of air which guides and protects the atomised fluid and, it is claimed, practically eliminates mist. It is added that the use of a greater volume of air at a lower pressure decreases the velocity of the spray and eliminates "bounce" of the paint. The gun may be used also for spraying other liquids. Illustrated leaflets.

Piezo-Electric Ceramics. TECHNICAL CERAMICS LTD., Wood Burcote-way, Towcester, Northamptonshire. An account of how barium titanate transducers and piezo-electric ceramics are manufactured and how they are the medium by which high-frequency oscillations are propagated for use in a wide range of applications, including depth sounding; the ultrasonic cleaning of machined parts, and the drilling and cutting of hard materials; the detection of flaws and the production of strain gauges. Illustrated brochure.

Instruments for Blast Furnaces and Control of Process Variables. GEORGE KENT LTD., Luton, Bedfordshire. Information on instruments for the blast-furnace plant, including the blowers, stoves, furnace platform, skip chargers, gas-cleaning plant, the control of fuel and the sinter plant. Also a description of the Hammel-Dahl diaphragm-operated valve for the control of process variables such as rate of flow, pressure, temperature or liquid level. Illustrated leaflets.

Silent Bar Guides for Capstans and Automatics. LATYMER ENGINEERING COMPANY, 27A Charles-street, Barnes, London, S.W.13. Bar guides or feed tubes for use with capstan lathes or bar automatics. The guide is a metal tube with an oil-proof lining. It prevents noise from the stock and protects the surface of the material from damage. Five sizes are made, with internal diameters from $\frac{1}{2}$ in. to $1\frac{1}{4}$ in. The guides are supplied in 13 ft. lengths. Illustrated leaflet.

Heat-Resisting Alloy Steel. THE CALORIZING CORPORATION OF GREAT BRITAIN LTD., Lynton House, 7-12 Tavistock-square, London, W.C.1. Data on the physical and mechanical properties, scaling rates and characteristics, and other high-temperature qualities of the firm's Calmet 25/12 chromium-nickel cast heat-resisting alloy steel. Illustrated brochure.

Surface-Finishing Process. PARIPAN LTD., 1 Sherwood-street, Piccadilly-circus, London, W.1. Details of the new Pateena process for applying a neutral-toned texture coat on metals, wood, hardboard, fibre, papier-maché and other materials. A finishing coat of any desired colour is then sprayed on. Illustrated folder and specimen coating.

Metal-clad High Voltage Cubicles. ATELIERS DE CONSTRUCTIONS ELECTRIQUES DE CHARLEROI, Charleroi, Belgium. Details of indoor and outdoor cubicles for housing withdrawable circuit-breakers and other equipment required for the operation of a high voltage installation. Details of design and construction. Fully illustrated booklet.

Types of Small Magnets. JAMES NEILL & CO. (SHEFFIELD), LTD., Napier-street, Sheffield, 11. Many types manufactured, described under the title "Small Magnets are so Versatile." Information regarding composition, dimensions, applications and other properties. Illustrated leaflet.

Rubber and Ebonite Linings and Coverings. SILVERTOWN RUBBER CO. LTD., Herga House, Vincent-square, London, S.W.1. Descriptions of methods of lining and covering tanks and other vessels, pipes and equipment with rubber or ebonite to give them lasting protection against the effects of chemical attack and abrasion. Booklet.

Portable Radio Sets. INDUSTRIAL RADIO SALES, Chicago, Illinois, U.S.A. Details of portable two-way radio sets (walkie-talkies), known as Pak-Fones and Field-Fones. Technical and constructional details. Illustrated leaflet.

Bin Vibrators. THE MAGNETIC EQUIPMENT CO. LTD., Lake Works, Portchester, Hampshire. Magnetic vibrators, including flame-proof models, for preventing clogging in storage bins. Also associated control gear. Leaflets Nos. 101 and 102.

Magnesium Alloys. BIRMETALS LTD., Woodgate Works, Quinton, Birmingham, 32. Lists of specifications and mechanical properties, and directions on fabrication, machining, joining and finishing magnesium alloys. Leaflet.

Wire. THE SPENCER WIRE CO. LTD., Wakefield, Yorkshire. A history and a review of the activities of the firm which this year celebrates its golden jubilee. Illustrated brochure.

Graphite Lubricant. JENOGRAPH LTD., 13-17 Rathbone-street, London, W.1. Jenograph graphite lubricants for engines gearboxes and machining. Folder.

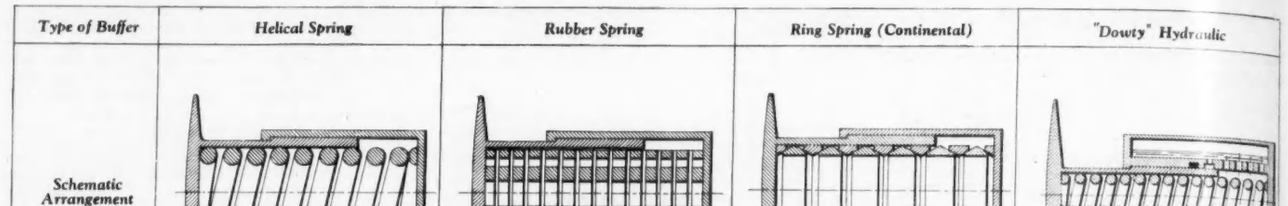


Fig. 1 Comparison of the characteristics of various types of buffer.

NEW RAILWAY BUFFER WITH CONTROLLED RECOIL

A new type of hydraulic buffer suitable for all types of freight wagons and Diesel rail-cars, based on the principle of energy dissipation rather than energy absorption, has been developed by the Dowty Group at their Ashchurch, Gloucestershire, factory. It is available with protrusions of 1 ft. 6 in., 1 ft. 8½ in., 1 ft. 10 in., and 2 ft. 0½ in., with a corresponding range of head sizes, for duty on current screw-coupled continuously-braked trains. The largest size is suitable for probable future British standards.

Basically, the Dowty buffer comprises a combined reservoir and cylinder, housing a piston loaded by a helical spring and secured in the cylinder by a split ring and trapped circlip (Fig. 1). On impact, fluid is displaced by the movement of the piston into the surrounding reservoir through a series of orifices in the cylinder wall. The restriction imposed on the oil flow causes a back pressure which reacts on the piston, giving the buffer its full resistance to closure. A screwed cap in the reservoir provides for initial filling.

The only dynamic seal needed is an O ring of synthetic rubber, backed by a chrome leather anti-extrusion ring. An important feature of the design is that the seal is never subjected to high pressure, for adjacent to its pressure side a groove in the cylinder wall intersects a number of holes leading to the reservoir. There is no pressure in the buffer when fully extended, and during the closing movement the seal is subject only to a low reservoir pressure.

Unlike a mechanical spring which provides a fixed resistance for any given closure of the buffer, the reaction of the Dowty buffer is related to the speed at which the buffer closes. Due to the square law governing flow through orifices, the pressure generated in the buffer is directly proportional to the speed of closure. Consequently, the Dowty buffer is self-adjusting to changes in impact energy resulting from changes in wagon velocity. The characteristics of the buffer are compared with those of other types in Fig. 1.

Violent recoil is obviated by the design of the buffer, which is based on the principle of energy dissipation and not energy absorption. Impact energy is converted into heat energy as the buffer closes, and the small quantity of air rapped in the reservoir is compressed slightly as displaced fluid raises the level in the reservoir. On completion of the closing movement, most of the impact energy has been dissipated and controlled recoil results from the combined effects of the load in the recoil spring and the air pressure. This is in direct contrast to the conventional spring buffer with its uncontrolled recoil.

As the recoil spring is completely immersed in the hydraulic fluid, it is fully protected against corrosion. The piston is corrosion-protected by chromium plating over its entire length.

The manufacturers claim that the basic simplicity of the buffer promotes long life and trouble-free operation. The small number of working parts and the absence of complicating features such as relief valves ensure its reliability and low cost. The absence of pressure on the dynamic seal and the buffer's independence of a compressed air source virtually eliminate maintenance and enable it to operate continually over long periods. Routine servicing can be quickly carried out during major wagon overhauls. Robustness of construction and great strength contribute to its long life.

The capacity of the buffer is approximately ten pints, which is 1½ pints in excess of the quantity needed to keep the pressure cylinder full. This safeguard of 1½ pints of fluid could be lost without impairing buffer efficiency, although the likelihood of this occurring is extremely remote, even over a long period. During extended life tests involving over 5,000 heavy impacts, fluid loss was less than 70 c.c.

The design of the buffer was preceded by an extensive research programme to obtain vital statistics on the wide variety of impact conditions met. This development provided for exhaustive tests with prototype units under the most arduous conditions.

Data were obtained by shunting a wagon into a buffer stop (Fig. 2), adjustment of the wagon weight and shunting speed enabling the buffer mounted on the stop to be subjected to shocks equivalent to those produced in actual impacts between wagons of any given weight. Both the reaction and closure of the buffer were measured electronically against a common time scale. To achieve this, a strain-gauge pick-up was inserted in the buffer and the signals due to pressure variation were recorded as a cathode-ray trace. Similarly, another trace giving buffer closure was obtained from a probe-type potentiometer attached to the stop block and actuated by the wagon.

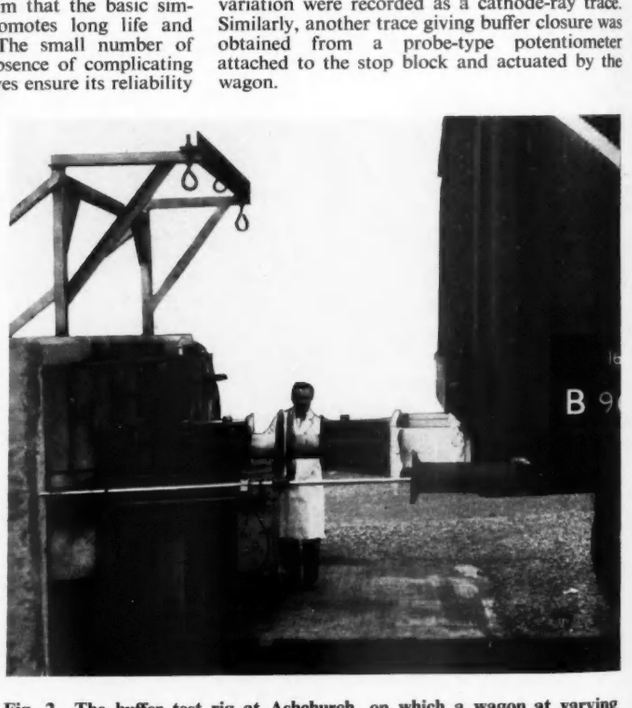


Fig. 2 The buffer test rig at Ashchurch, on which a wagon at varying weights was shunted at varying speeds into a buffer stop. Reaction and closure of the buffer were measured electronically.

HALVING THE WEIGHT OF A LIGHTWEIGHT COACH

It seems that the standard lightweight coach has no longer a valid claim to its name. The Pioneer III—produced by the Budd Company, Philadelphia, U.S.A.—is less than half the weight of its forerunners in this class and promises to be a new yardstick for the lightweight designer. The company's imaginative approach to the problem of weight reduction would seem to stem from the experience gained by them in constructing aircraft: both the exterior and the interior of the coach, shown in the photographs, bear witness to the influence of aircraft practice, as does the use of lightweight materials throughout the whole structure.

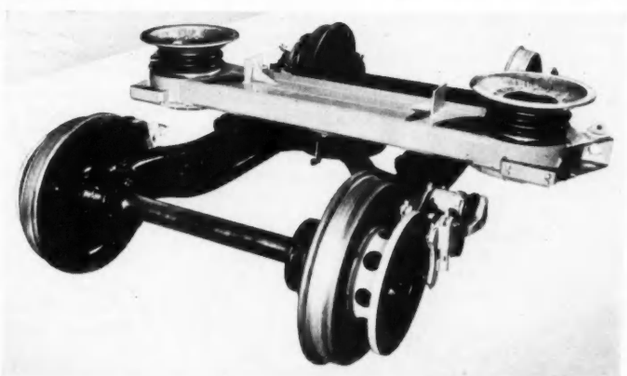
However it has been more than a matter of replacing heavy materials with lighter ones. The bogie structure, for instance, has been completely reilesigned. Whereas the bogies of a standard American lightweight coach weigh 38,100 lb., those of Pioneer III weigh 13,060 lb. This impressive reduction in weight is said to have been achieved with no reduction in strength, while the resulting unit, as shown in the illustration, is both simple to fabricate and easy to maintain. The principal members of the bogie are two side frames, a bolster, and two air-springs. These last, which appear in the illustration as bellows at the end of the bolster, work in conjunction with a large pneumatic reservoir in the bolster beam. By inserting an orifice between the bellows and the reservoir, a composite spring of variable rate and intrinsic damping is obtained. Small track irregularities are smoothed out, as they cause the system to act as a soft spring with light damping, while large irregularities cause the system to act as a stiff undamped spring and are therefore effectively cushioned. By locating the springs adjacent to the side frames of the coach, the designers have avoided the introduction of large bending loads such as would require a much heavier bogie. Its side frames, formed of two stampings welded together, are joined around a central pivot bearing attached to the bolster beam. Inside roller bearings are used for the hollow axles, allowing the use of easily accessible disc brakes and the speeding up of wheel maintenance.

The main body of the coach shows how unusual materials may be used to their best advantage. Laminated plastics reinforced with fibre glass have been used for air ducts and interior panelling, where they have permitted the achievement of a single-piece design of elegance and serviceability: elegant by virtue of the absence of joints and supports, serviceable by virtue of the ease with which such a structure may be cleaned. Furthermore, the facility with which this material may be moulded to the shapes desired makes it cheaper to use than metal. At each passenger bay a single reinforced plastic panel extends from the heater guard to include the window surrounds and the lower portion of the luggage rack. A second panel comprises the upper section of this rack, the ceiling, and half of the air duct. Treated fir plywood is used for the flooring, and the space between it and the corrugated steel under-sheeting is filled with isocyanate foam—an efficient insulant for both heat and sound. Corrugated stainless steel sheet has been used extensively on the outside of the coach, and aluminium mouldings are used to join the individual plastic panels inside the coach. The piping used, with the exception of that carrying hot water from the electric heater, is of vinyl plastic which, besides being uncorrodable, is sufficiently flexible to expand when ice is formed within it and so obviates freeze-up troubles.

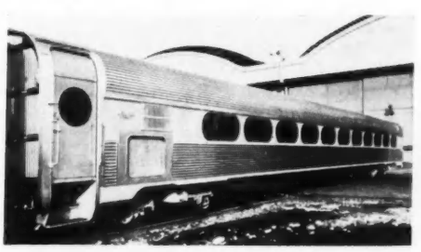
The manufacturers emphasise that Pioneer III is a basic unit which can be adapted as a main-line coach, a sleeping car, dining car, etc. The light weight and high carrying capacity fit it particularly for suburban services.

Comparative Weights

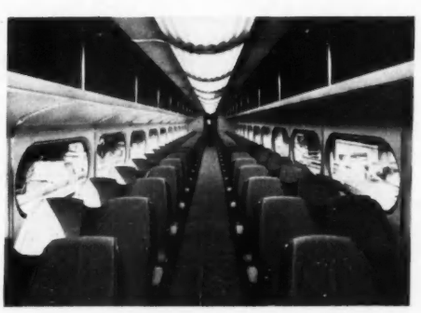
Item	Weight in lb.	
	Pioneer III	Standard lightweight coach
Coach body	26,005	44,250
Equipment and supports ..	6,115	26,250
Interior trimming, etc. ..	7,150	14,600
Bogies	13,060	38,100
Weight per passenger ..	595	1,678



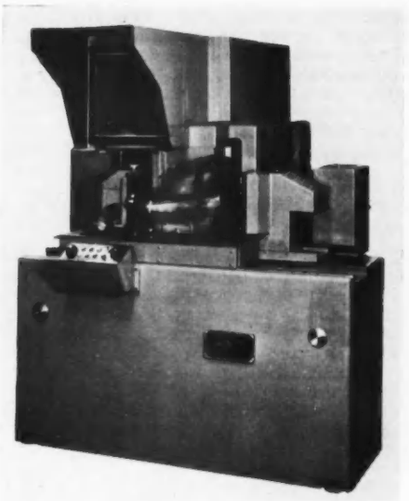
A bogie from the Pioneer III passenger coach. The two air springs and a disc brake can be clearly seen.



The influence of aircraft design is apparent in this exterior view of the Pioneer III.



The interior view of the coach shows the passenger bays with their single-piece moulded plastic panels.



A new projection pantometer which provides for inspecting turbine blades up to 24 in. long, 6 in. wide and 2 in. thick, and for checking the contour, size and section displacement and twist of any pre-determined section.

INSPECTING LARGE TURBINE BLADES

Projection Pantometer

A new projection pantometer has been introduced by Optical Measuring Tools, Limited, Maidenhead, for the inspection of turbine blades up to 24 in. in length and 6 in. chordal width, with a permissible thickness of 2 in. Provision is made for checking the contour and size of any pre-determined section and also the section displacement and twist.

The principle used in the contour and size check is that of a stylus follower with optical reproduction of its path, as already employed in the company's standard and model "E" pantometers. The blade is mounted horizontally on the instrument table by means of a workhead, or headstock, which has co-ordinate movements in the vertical and horizontal planes and rotational movement about the horizontal axis, each of these co-ordinate movements being actuated by micrometers. Two diametrically-opposed styli are mounted on slides and each is connected to an objective lens. A disc containing separate graticules of each blade section to be checked is mounted beside the screen unit, in such a manner that it rotates through the vertical plane. The graticules are so arranged that light from the lighting unit passes through the graticules and objective lens and is transmitted to the screen where any observed image is at × 30 magnification. The screen, 16 in. square, contains a tolerance graticule in the form of concentric circles, the mean circle representing the diameter of the stylus at × 30 magnification and the others representing permissible tolerances. As the stylus traverses the blade contour so its objective lens follows an identical path and projects the relevant part of the graticule to the screen; thus the image of the graticule is observed to pass across the screen and, if the blade is correct, through the tolerance zone.

In addition to the stylus carriages there are two position indicators mounted on ball slides, and any displacement of section, or twist, is indicated by two "spot" graticules associated with the indicators. A setting plug is used to establish the correct position of the indicators, after which they are brought into contact with the leading and trailing edges of the blade, and any deviation is shown by the displacement of the "spots" on a small screen immediately below the main screen. Should there be no error, both spots should coincide with the

centre of the cross-lines, but if an error is present it can be allowed for and measured by means of the micrometers on the work-holding head.

The principal operational movements of this instrument are power-controlled and the table traverse, the graticule location, the stylus travel and the positional indicators are all operated by push buttons. This considerably reduces inspection time and will eliminate errors on the part of the operator.

Marketing

SUPPLIER AND CUSTOMER MEET

A convention was held by the British Steel Founders' Association recently with the object of bringing together founders and their customers. It is most surprising, and gratifying to those who have long preached the need for it, to see how quickly this post-war tendency to bring customers and suppliers together is gathering momentum. The chairman of the B.S.F.A., Mr. G. M. Menzies, who is chairman of the North British Steel Foundry, Limited, emphasised the agreement which already exists between users and makers of castings that closer collaboration is needed between them and that it must not be confined to the discussion of difficulties when they arise. It should take place " when the design of parts which are to be cast is being worked out."

The problems of the steel founding industry were given a good airing, and the points of view of users were forcefully put forward in a paper by Dr. S. F. Dorey, retiring Chief Engineer Surveyor of Lloyd's Register of Shipping. There is evidently a great deal of scope for closer co-operation at an earlier stage. As Mr. Menzies said, " steel castings are invariably vital components in the structures of which they form a part," but unlike most other components they are produced " without prototype work having been undertaken."

The possibilities of better and often simpler designs, of adopting industry-wide standards, and of greater mutual understanding of production problems through such a convention are very real. Whenever people gather together to discuss and hear views on matters in which they have a vital interest—particularly engineers—new ideas, a clearer insight and a more critical attitude inevitably result.

★ ★ ★

Packaging Methods and Machines

Changing habits and changing techniques will be in evidence at a convention organised by the Institute of Packaging in conjunction with the Packaging Exhibition to be held at Olympia, London, from January 22 to February 1. The purpose of the convention—entitled " Better Packaging Means Better Living "—is to outline what changes in distribution and selling methods can be expected to have an impact on the type of manufacture and packaging at producing centres.

Though much will be said about food, public tastes and preferences, and about methods of retailing, a great deal will be of interest to engineers. Nearly a third of the exhibitors are machinery makers, and there have been so many developments in the design of packaging machines that " present factory packaging methods could be revolutionised."

The convention is planned to open with the retailers' forecasts of changes in demand for food in the next few years—volume, tastes and preferences—and how retailing methods are likely to change. Food manufacturers will give their views on " known tendencies and developments " and tell retailers how far the manufacturers can meet their forecasts. The packaging industry will complete the proceedings by telling retailers and producers how it can cope with their demands and what packages, containers and machinery they will have to offer in the next two to five years which may influence present thinking. This type of gathering is an interesting concept for bringing together inter-related industries. Well organised, it could yield much that is stimulating and useful in a practical way. The method has applications in other industries.

★ ★ ★

The Coverage of Trade Fairs

There was additional news last week of two major trade fairs to be held in the spring: the Brussels International Trade Fair, from April 27 to May 12, and the British Industries Fair from May 6 to 17. At about the same time there are three exhibitions in London and trade fairs in Lyons, Basle, Liège and Hanover. The overlap will give a buyer a first-class opportunity to see all that Western Europe has to offer him. Most of these fairs are general ones, with the broadest possible appeal.

The argument for a general fair is interesting and good enough to meet the challenge made by specialised exhibitions. These have been multiplying since the war and there are now 50 of them from January to December, a good many overlapping from the exhibitor's point of view. His sales staff spend a surprising time of the working year on a stand, often waiting for visitors. The buyer is worse off still: if he needs machines, instruments, steel castings, plastic gears, electric motors, etc., he must visit one exhibition for each item. Thus the specialised exhibition is in danger of defeating its main purpose, which is to concentrate in a small space a narrow range of products sold and demonstrated by specialists so that the buyer is better " sold " and in less time.

A well-organised B.I.F. could give a broader view, more balanced and more representative of British industry or of a particular industry's suppliers. It could make unnecessary a great number of more " clannish " gatherings. But it has yet to prove itself. The old B.I.F. did not: the new one will have to do so in terms of attendance and business transacted. Well publicised, it could do all this and much more, being the one occasion during the year which makes it worthwhile for overseas buyers to come to the heart of Britain.

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Birmingham 1957—Brussels 1958

The British Industries Fair, now backed by the Birmingham Chamber of Commerce, who took over this year from the Government, will be held at Castle Bromwich. The Chamber owns sixty acres of exhibition grounds, which leaves them ample room for expansion should this new B.I.F. prove a success. The venture is being well publicised and so far, with five months to go, 40 per cent. of last year's exhibitors have rebooked. New bookings are equal to 78 per cent. of the total number of new firms who booked sites in 1956.

The export angle is prominently displayed by the organisers, who have issued invitations to overseas buyers in more than 100 countries. The President of the Board of Trade, Mr. Peter Thorneycroft, assured the Birmingham Chamber of Commerce of the Government's continued interest in the Fair " as a method of promoting exports " and stressed " the importance of using the opportunity presented by the Fair to show the world the vitality and progress of British industry." There is little doubt that, properly publicised, adequately financed and well organised (not forgetting accommodation), the B.I.F. could be the occasion which draws to Britain the overseas buyer who cannot cover a multiplicity of specialised shows.

Last week Mr. Thorneycroft pressed a switch which set in motion a bulldozer on the British site for the Brussels Universal and International Exhibition, 1958. In the view of the Federation of British Industries, the exhibition is " not a trade fair but a far larger undertaking at which some fifty nations will display their way of life, their industrial products and the contribution which they have made or are making to human progress." It will be the first international exhibition to have been held since the war. The British site will be chiefly given over to two pavilions: the British Government pavilion, which will display our way of life and our contribution to civilisation, and the British industries pavilion, where industry will display the part it has played and will play in making that way of life and that contribution possible. All countries participating will take a total of 500 acres and will spend £100 million, two-thirds of which will be paid by Belgium. Probably a very good investment.

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More Centralised Selling

The Owen Organisation have announced that two of their member firms, Salopian Engineers Limited and Kenneth Hudson and Son, Limited, will concentrate solely on design and marketing. S.E.L. will handle the group's tubular equipment only, and Kenneth Hudson will sell the agricultural machinery made by Rubery, Owen and Company, Limited, at Darlaston.

These arrangements confrom to a pattern now emerging fairly clearly in British engineering. It is a time-honoured method which brought success to companies such as Head Wrightson Henry Simon, Mitchell Engineering and many other leading " design and marketing " concerns. It tends now to be the way favoured by groups of companies, using establishments to manufacture and headquarters to design and sell, carrying out all the necessary research—whether marketing or product.

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PRODUCTION OF IRON CASTINGS

There has been a slight easing in the output of iron castings during the third quarter of the present year. Figures issued by the Iron and Steel Board, Norfolk House, St. James's-square, London, S.W.1, show that the production of iron castings in the three months ending September 30, 1956, was 863,980 tons, compared with 879,680 tons in the corresponding period of 1955, a decline of 1·8 per cent. The output for the first three quarters of 1956, however, was 2,925,660 tons against 2,884,360 tons in the first nine months of 1955, an increase of 1·4 per cent.

Discussing these statistics, a commentary issued by the Council of Ironfoundry Associations, 14, Pall Mall, London, S.W.1, states that the third quarter of the year covers the holiday period and that, consequently, output is low when compared with the other quarters. Moreover, this year, holidays have been taken later than is customary and this has tended to upset the normal pattern of production.

Although the output of iron castings for the engineering section of industry, in the third quarter of 1956, showed a small reduction when compared with the third quarter of 1955 (i.e., from 326,800 tons to 320,700 tons), certain important constituent industries of the section, for example, the machine-tool and electrical-engineering industries and iron and steelworks plant, continued to show significant increases. Furthermore, the output of ingot moulds for steelworks use and of iron castings for railway equipment, showed up favourably in comparison with 1955.

ADVANCED POWER REACTORS

2—SYSTEMS SHOWING PROMISE FOR THE FUTURE

Last week on page 694 we published the first of three articles on advanced reactors, two more of which appear to-day. The initial article, which was of an introductory nature, was concerned generally with the scope of the United Kingdom programme, and with the possible course of future development. In addition some of the factors involved in raising reactor heat rating and efficiency were outlined, with special reference to the gas-cooled graphite-moderated system. This week we publish some comments on the very-high-temperature (VHT) gas-cooled reactor, and a comparison, prepared at our request by Mr. G. W. K. Ford, of the pressurised-water and sodium-graphite systems. Some notes on boiling-water reactors, notably the forced-circulation and dual cycle systems, which are favoured in certain quarters, appeared on pages 669 and 670 of our issue of November 23, and a general discussion of water-cooled reactors appeared on January 20, page 78 (1956). The article below on the very-high-temperature system was extracted from a paper presented by Mr. R. V. Moore at the "Symposium on Calder Works Nuclear Power Plant," held by the British Nuclear Energy Conference on November 22 and 23, and from papers presented at a "Symposium on Nuclear Gas-Turbine Power Plants," held by the Washington section of the American Society of Mechanical Engineers. Schematic views of six advanced reactors appear on page 726

VERY HIGH TEMPERATURE REACTOR

GAS COOLING AND CERAMIC FUELS

In a previous article we considered the advantages that higher temperatures would bring in the operation of gas-cooled nuclear reactors, and this led to the suggestion that ceramic fuels might profitably be employed. The prospect of using such fuels (comprising oxides or carbides of uranium, plutonium or thorium) and the fact that graphite itself is a refractory material have drawn attention to the possibility of developing a very-high-temperature (VHT) gas-cooled reactor, operating at about 800 deg. C., in which all metals are excluded from the core. It is a system, which has recently found considerable support, and might be developed to operate on a plutonium-thorium transition cycle producing power and uranium 233 as a by-product, or be used in plants with a high power-to-weight ratio requiring highly enriched fuel.

Compared with the corresponding metals, the oxide or carbide fuels have much higher melting points, are brittle, and soften only at comparatively high temperatures. Most ceramics have a thermal conductivity much lower than metals, but this is not the case with the uranium carbides, which have similar values to metallic uranium. Some properties of the oxides and carbides of uranium are given in Table I below.

Uranium oxide was used in the first reactor built in the United Kingdom (GLEEP) but uranium metal was later preferred as its density is higher, a favourable property from the nuclear point of view, particularly important when natural uranium is used. But as concentrated fissile materials become available, interest in the

TABLE I.—*Properties of Uranium and its Oxide and Carbides*

—	U	UC	UC_2	UO_2
Melting point, deg. C.	1,133	2,250	2,260	2,500
Density	19	13·5	11·28	11
Thermal conductivity at 50 deg. C., C.H.U./h.ft.deg. C.	3·75	4·6	0·47	0·29

ceramic forms of uranium will probably return, so making possible the VHT reactor. Generally speaking, ceramics are more resistant to coolant attack than metals; uranium oxide (UO_2) is inert both to carbon dioxide and hydrogen. The oxide and the monocarbide (UC) are reasonably stable in air, although the higher carbides of uranium and thorium (UC_2 and ThC_2) are very reactive. In addition to their favourable high-temperature properties, there is some experimental evidence to indicate that their irradiation resistance is much better than that of the metals.

Naturally one of the most important considerations in designing a reactor is to achieve the highest possible heat output from a given quantity of fuel. Fuel rating is generally discussed in terms of heat removed from a given mass of uranium (MW per tonne), only a small proportion of which, in natural or slightly enriched uranium, is fissile material. This definition of rating carries with it a concept of the size of the plant; possibly some 20 per cent. of the capital cost of a plant is inversely proportional to this figure. The fuel inventory

TABLE II.—*Uranium and Fissile-Material Ratings*

—	Uranium rating, MW per tonne	Fissile-material rating, MW per kg.
Calder Works	1·4	0·2
Case A: Larger Calder design	2·0	0·3
Case B: High temp. reactor (flattened)	5·8	0·8
Possible VHT reactor	—	1–2

charge is also reduced as the rating is increased. Another way of expressing fuel rating is in terms of fissile material, a concept more important in relation to fuel cycles. With natural uranium the fissile material rating is 140 times the uranium rating. Table II shows the uranium and fissile-material ratings for the reactors discussed in the previous article in this series (see Table III, November 30, page 697), and for a possible VHT reactor. With the VHT reactor the possibility exists of virtually "diluting" the fissile material with the moderator, in this case high fissile-material ratings are possible, as is apparent from Table II, and at the same time good neutron economy is preserved.

At the high temperatures associated with this type of reactor—typically, a gas outlet temperature of 800 deg. C. (1,472 deg. F.)—the problems associated with materials are acute. Attaining a high degree of thermal and irradiation stability of the graphite and the ceramic fuel at high temperature and high neutron flux presents a formidable research problem. So does preventing the spread of fission products into the primary cooling circuit. These ideally should be confined to the fuel, as with conventional fuel elements clad in metal. The incentive for development, however, is high. It is calculated that the overall efficiency of such plants could exceed 40 per cent., while the high fuel rating would lead to a further reduction in the capital cost per kW, when compared with high temperature reactors with metallic cladding of the fuel elements (Case B of Table II).

GAS TURBINES

Once the VHT system with its high gas temperatures has been developed, the use of gas turbines in reactor plants becomes worth while, and it is likely that a gas-turbine cycle will in fact be adopted for this type of reactor. For plants of large power output, a cycle generally similar to that developed by Escher-Wyss, of Zürich is applicable. Preliminary calculations for such a plant have been carried out at Chalk River, Canada. The general layout of the system is shown in the diagram below. The hot gas from the reactor feeds high and low pressure turbines, the latter driving the alternator. Two-stage compression with intercooling is used, and the high and low pressure compressors are driven by the high and low pressure turbines respectively.

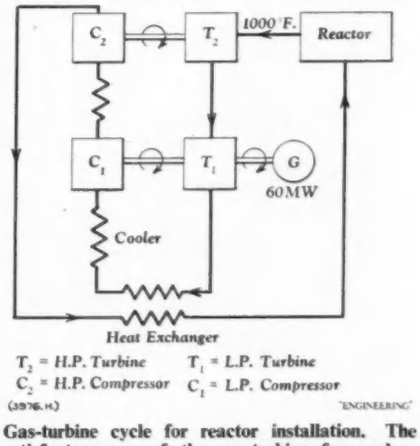
In comparing the merits of carbon dioxide and helium, it has been shown that the rotating machinery for the carbon dioxide cycle has approximately half the volume of that required for the helium plant, but the heat exchangers have nearly double the volume, which suggests that marginally the carbon dioxide plant might be cheaper to build. In carrying out preliminary design calculations for a 60 MW (electrical) plant a gas pressure of 300 lb. per sq. in. abs. and a top gas temperature of 538 deg. C. (1,000 deg. F.) have been assumed. These conditions are particularly interesting as they probably represent something near the minimum conditions for such a cycle, requiring machinery that is large and costly yet possible to design and construct. Even at 538 deg. C. the calculated efficiency is 29 per cent. and if this temperature were raised to 677 deg. C. (1,250 deg. F.), this would increase to 38 per cent. For the capital cost of the plant to be competitive with steam plants it would appear, however, that the system pressure would have to be considerably higher than 300 lb. per sq. in. gauge.

It can be seen that to achieve reasonably economic operation, considerably higher gas temperatures are desirable, and it is here that the VHT system, operating at 800 deg. C., proves its value. But for the gas-turbine cycle shown in the diagram to be feasible, fission products would have to be contained within the reactor.

OPEN AND CLOSED CYCLES

As a basis for determining the most suitable gas-turbine plant for operation with a VHT reactor, it may be useful to consider some of the gas-turbine-reactor combinations already planned. It is also necessary to determine which of the available reactor coolant gases should be chosen as working fluid. These were compared in the previous article in this series (page 697) and certain of them are employed in the gas-turbine-reactor systems discussed below.

Given that the reactor can deliver its thermal energy at a reasonably high temperature, say 650 deg. C. (1,200 deg. F.) to 800 deg. C. (1,500 deg. F.), both closed and open cycle systems may be used. With these conditions, the closed-cycle plant is said to offer flexibility of design, economy in space and weight, and good efficiency. The main advantage of the open-cycle gas turbine is its relative simplicity, which is most effectively realised in the single-loop air-cooled system. Its natural field of application is thus in conditions where simplicity



T_2 = H.P. Turbine T_1 = L.P. Turbine
C_2 = H.P. Compressor C_1 = L.P. Compressor

(3976.H.) "ENGINEERING"

Gas-turbine cycle for reactor installation. The satisfactory use of the gas-turbine for nuclear power generation is likely to depend on the development of the very-high-temperature reactor.

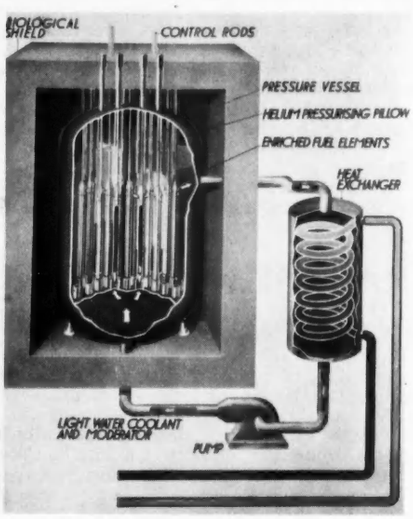
and reliability are preferred to highest possible thermal efficiency; these are most likely to occur in the case of small plants of the order of 1 MW or less, in which capital costs considerably outweigh fuel costs. As air is used as reactor coolant, working fluid, and auxiliary cooling medium, the plant is independent of both special gas and cooling-water supplies.

Design studies have been carried out for small gas-turbine reactor plants of 200 kW and 2,000 kW electrical capacity. For the former, an open-cycle plant has been chosen having an air-cooled reactor with a thermal output of 1,970 kW. The air heated in the reactor flows directly into the turbine. Beryllium oxide blocks are used as moderator, and the initial fuel charge is about 25 kg. of uranium 235. The turbine itself weighs only 854 lb. and tests have shown that with a turbine-inlet temperature of 720 deg. C. (1,325 deg. F.) it should provide the power required for a 250 kW generator. It should be possible to achieve this without raising the fuel-element temperature above 800 deg. C. (1,500 deg. F.). The cycle efficiency is said to be 12·7 per cent. and the terminal efficiency 10·2 per cent.

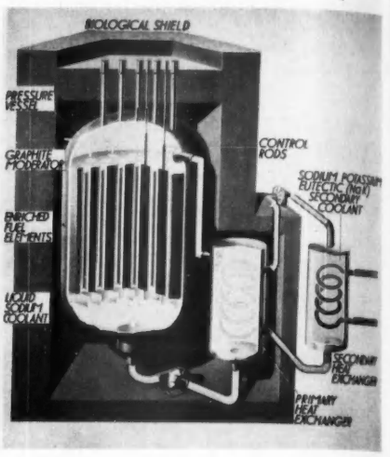
The 2,000 kW plant employs the Escher-Wyss Tuco 52 closed-cycle turbine and a nitrogen-cooled graphite-moderated reactor of 7 MW thermal output. Uranium oxide is used as fuel, and the initial charge is less than 25 kg. The nitrogen temperature at the turbine inlet is 660 deg. C. (1,220 deg. F.); the cycle efficiency is 34·5 per cent. and the terminal efficiency 31 per cent.

A preliminary design study has also been made for a 15 MW closed-cycle gas-turbine nuclear power plant which may prove suitable for application to ship propulsion. The fuel-element material is metallic or cermet-metallic and the overall size of the reactor vessel is about 9 ft. in diameter and about 13 ft. in height, including the control-rod mechanisms. Nitrogen has been chosen as the working fluid, and for the moderator material both beryllium oxide and graphite have been considered. The turbine inlet temperature is 700 deg. C. (1,292 deg. F.) and the terminal efficiency is about 34 per cent.

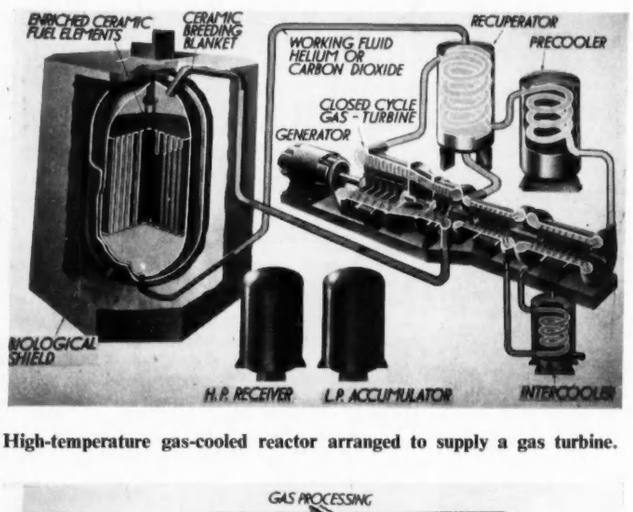
Initial calculations have also been made for a 240 MW plant using helium as the working fluid; these indicate that if the smaller system is feasible so is the larger. One of the outstanding problems to be solved is the construction of fuel elements that can withstand the high operating temperatures, mechanical and thermal stresses, and radiation damage. It is thus clear that the development of the VHT reactor, with its ceramic fuel dispersed in graphite moderator is likely to precede the satisfactory use of the gas turbine in reactor engineering.



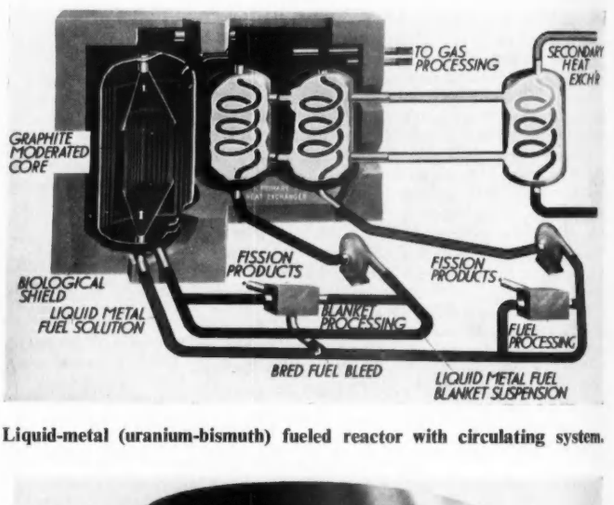
Pressurised-water moderated and cooled reactor.



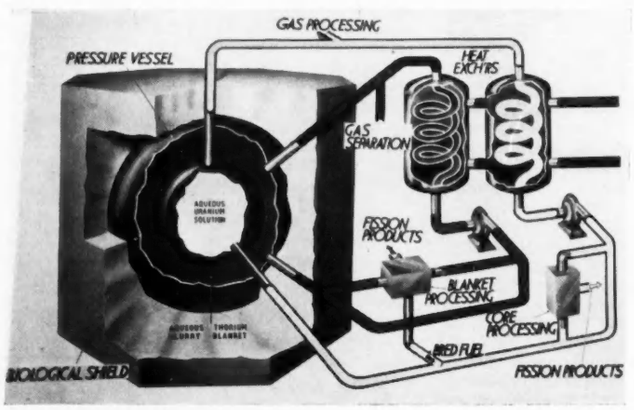
Sodium-cooled graphite-moderated reactor.



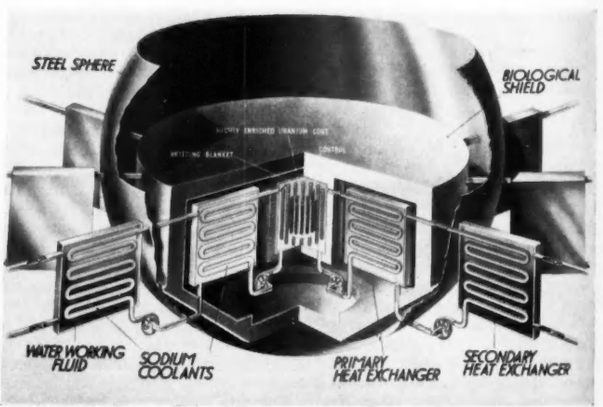
High-temperature gas-cooled reactor arranged to supply a gas turbine.



Liquid-metal (uranium-bismuth) fueled reactor with circulating system.



Aqueous homogeneous reactor with continuous fuel processing.



Fast breeder reactor (as building at Dounreay) with liquid-sodium cooling.

SCHEMATIC VIEWS OF SIX ADVANCED REACTORS WITH ASSOCIATED PLANT

(Reproduced from Atomic Energy Research Establishment photographs)

TWO POWER REACTORS COMPARED

PRESSURISED-WATER AND SODIUM-GRAPHITE SYSTEMS

By G. W. K. Ford, M.B.E., M.A., A.M.I.MECH.E., A.M.I.E.E.

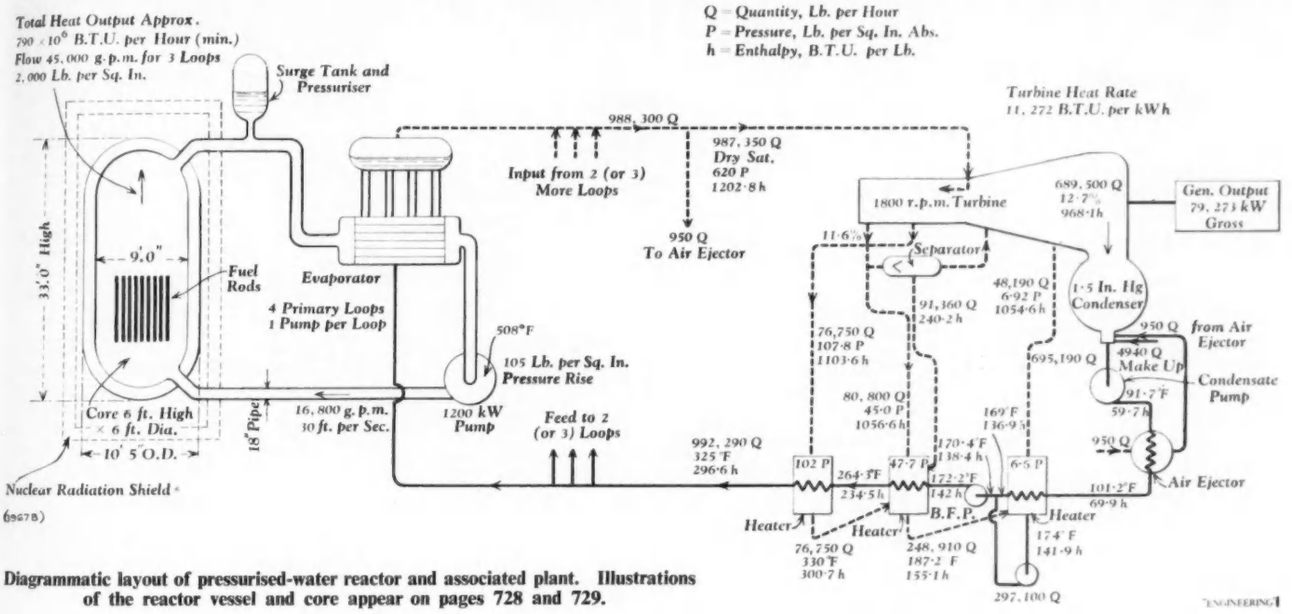
As will be gathered from earlier articles in the current series, any decision to build a power reactor must be preceded by feasibility and comparative studies. In the early stages of the United Kingdom programme comparison of different reactor systems played only a minor part, since choice was radically limited by technical, economic and geographical considerations. But as atomic energy development proceeds, it will become increasingly necessary to discriminate between alternative systems, particularly in this country where resources for a wide range of prototype plants are not available. It may be of interest therefore to consider the sort of factors involved in a typical comparison between two kinds of reactor. We therefore asked Mr. G. W. K. Ford, who prepared our article last year on "Power Reactor Projects Throughout the World" (vol. 180, page 490, 1955) to extend one part of these comparisons to bring out in more detail some of the competing features of the sodium-graphite (SG) and pressurised-water (PW) systems.

Now that the first "Stage I" power reactor has been successfully launched on its way, it becomes of interest to re-examine the possibilities of the next stage of power-reactor development. This short article will therefore consider the outstanding properties of two more or less directly competitive types of reactor which have for a long time claimed the serious attention of nuclear engineers, namely, the sodium-graphite and pressurised-light-water systems. Both these types require at least slightly enriched fuel, but both appear to be within striking distance of being developed into machines with a conversion factor close to unity. Both are intermediate in size, compared with the essentially large natural-uranium fueled gas-cooled graphite-moderated reactors, because of the cooling properties of liquid coolants and the fuel enrichment employed, but are large enough to be of interest for power station duty.

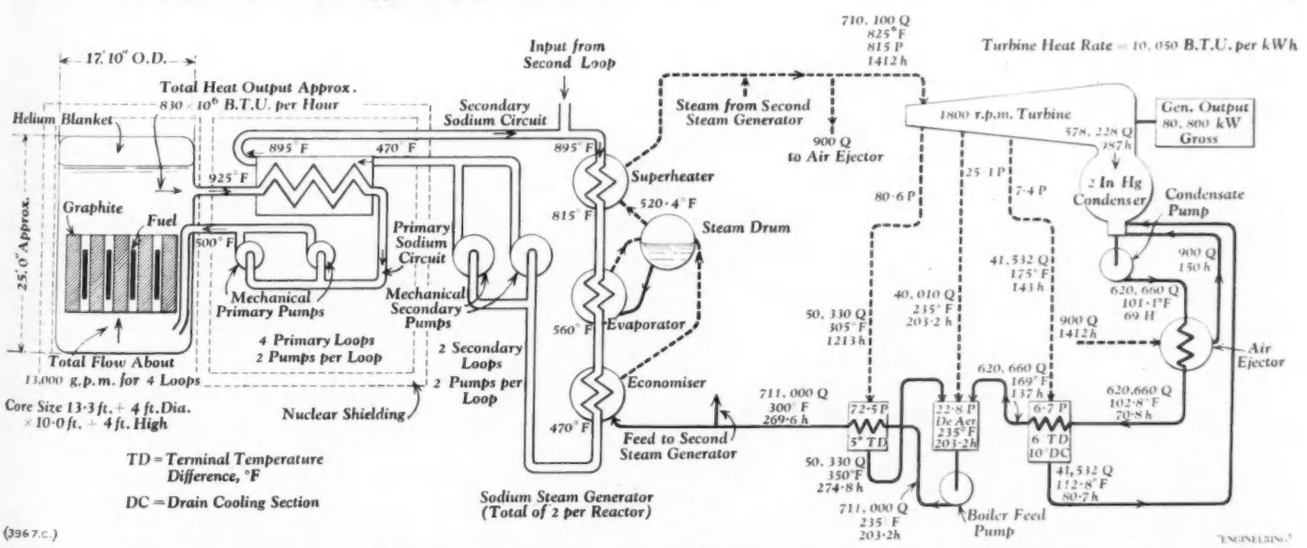
More highly enriched versions of these types having a smaller physical size and total power output would be of more interest for mobile applications and would not be economic for central-station electricity generation. Other types of highly enriched reactors such as the homogeneous aqueous solution and the heterogeneous bismuth solution types, although potentially economic, are somewhat further away in regard to technical development than the two types to be considered. However, it should not be assumed that the PW and SG types are the only contestants for the Stage II race, for such propositions as the Canadian heavy-water-moderated and heavy-water-cooled NPD reactor, using near-natural uranium, and possibly even gas or sodium-cooled heavy-water reactors have considerable merits of their own; the high-temperature gas-cooled graphite-moderated reactor is also, of course, a serious competitor.

For the present purpose, however, it is of interest to consider the SG and PW designs because fully-developed designs are available for each type, by good fortune, of approximately the same power rating, in the two Geneva papers P.493 and P.815. It is upon these papers that the comparative notes which follow have been based.

It is not intended to describe fully the design and construction of these reactors, which by now will have become familiar from the Geneva papers and various survey articles. However,



Diagrammatic layout of pressurised-water reactor and associated plant. Illustrations of the reactor vessel and core appear on pages 728 and 729.



Arrangement of sodium-graphite reactor and power plant. Details of the reactor are reproduced on page 730, and a view of a fuel-element cluster on page 729.

to remind readers of their main features the accompanying drawings of the core assemblies and heat circuit diagrams have been reproduced.

PW REACTOR

The important features of the pressurised-water reactor are that the coolant and moderator are both light water, and that the steam pressure and temperature are limited by the economics of containing high pressures, which considerations result in the working pressure of reactors of this type being limited to about 2,000 lb. per sq. in., to which corresponds a saturation temperature of 636 deg. F. (335 deg. C.) It is therefore necessary to keep the hottest point in any fuel element a few degrees below this temperature to prevent the occurrence of surface boiling.

The primary water from the reactor is circulated in four separate primary loops through four steam generator units. The highest available primary water temperature makes it necessary to supply the steam to the turbines in the dry saturated condition, there being no excess temperature available to provide superheat. This results in lowered thermodynamic efficiency as compared with superheater plants and also results in the formation of water droplets during expansion in the turbine with consequent blade erosion difficulty which, in the present design, is limited by appropriate hard facing of those parts of the turbine likely to be affected. This takes the form of Stellite facing applied to the leading edges of blading wherever the wetness is greater than 6 per cent. and the blade tip speed exceeds 900 ft. per second. The cylinder barrel, between rows of blades, will be lined with stainless steel applied by welding.

SG REACTOR

The sodium-graphite reactor has the great advantage of working at about atmospheric pressure, and the high outlet temperature of the primary coolant enables superheated steam to be supplied to the turbine. In fact, as will later be seen, if the sodium-graphite reactor type is developed so as to use thorium-uranium 233 alloy fuel elements it is likely that the thermodynamic performance of the plant will be limited only by the available steam-turbine technology. It may well be that this type of reactor would eventually be more appropriately coupled to a gas turbine rather than to steam heat conversion equipment.

Like the pressurised-water reactor design, this sodium-graphite design has four primary (sodium) loops, but it only employs two secondary sodium loops and associated steam generators. Both reactor projects are so arranged that the reactor can continue working with one or two of the loops out of service, thus giving the maximum flexibility of operation and at the same time providing for safety and reliability by the sub-division of the coolant circulation duty.

TABLE.—Comparative Data for Corresponding Pressurised-Water and Sodium-Graphite Reactors

Item	—	PWR	SGR	SGR (future development)
Nominal electric power output	MW	60–100	75	125
Reactor heat output	MW	238	250	400
" " "	B.Th.U. per hr.	790 × 10⁶	830 × 10⁶	1,330 × 10⁶
	(C.Th.U. per hr.)	(439 × 10⁶)	(461 × 10⁶)	(739 × 10⁶)
Steam pressure	lb. per sq. in.	600	815	1,265
Steam temperature	deg. F. (deg. C.)	486·3 (252·4)	825 (440·6)	950 (510)
State	State	dry sat.	superheated	superheated
Degree of superheat	deg. F. (deg. C.)	nil	305 (151·7)	368 (186·8)
Feedwater temperature	deg. F. (deg. C.)	325 (163)	300 (148·9)	300 (148·9)
Overall plant efficiency	per cent.	29·5[1]	31·6	33·6
Approx. capital cost, per installed kW	dollars (£)	1,000 (357)	300 (171)	200 (71)
Power cost, per kWh	mills. (*d.*)	—	10·5[2] (0·9)	6·0[2] (0·51)
Primary circuit design pressure	lb. per sq. in.	2,500*[3]	approx.	approx.
Primary circuit operating pressure	lb. per sq. in.	2,000*[3]	atmospheric[4]	atmospheric[4]
Fuel data:				
Cladding material	material	Zircalloy 2	stainless steel	stainless steel
Natural uranium oxide	tons	12	—	—
1·8 per cent. enriched uranium metal	tonnes	—	24·6	—
U233 or 235 (in Th 232 alloy)	kg. (lb.)	—	—	518[5] (1,140)
U235 (in Zr alloy)	kg. (lb.)	52 (114)	—	—
Thorium	tonnes	—	—	24·9[5]
Overall fuel enrichment	fissile, per cent.	1·1	1·8	3·7
Uranium burn up expected	MWD per tonne	3,000	3,000	10,000
Pu atoms formed per U235 atom burned (conversion factor)	factor	0·8	0·72	—
U233 atoms per U233 or 235 burned	factor	—	—	0·95[6]
Fast fission factor (*f*)	factor	1·08	1·026	1·000
Max. fuel temp.:				
UO_2	deg. F. (deg. C.)	2,200 (1,204)	—	—
U/Zr alloy	deg. F. (deg. C.)	—	—	—
Uranium metal	deg. F. (deg. C.)	—	1,200*[7] (649)	—
Th-U233 alloy	deg. F. (deg. C.)	—	—	2,000 (1,093)
Max. surface heat flux	B.Th.U. per hr. per sq. ft.	382,000 (212,000) U/Zr elements	350,000 (194,000) U metal	~640,000[5] (356,000) Th metal
	(C.Th.U. per hr. per sq. ft.)			
U/Zr, U and Th elements	watts/per sq. cm.	120	110	~200[5]
UO_2 elements	B.Th.U. per hr. per sq. ft.	240,000 (133,000) UO_2 elements	—	—
	(C.Th.U. per hr per sq. ft.)			
	watts per sq. cm.	74·5		
Power density in fuel	kW per kg.	10	9·2	23·3
Power density in U233 or 235	kW per kg.	1,500	565	694
Power density in moderator	kW per kg.	70	3·5	6·2
Leading dimensions:				
Core diameter	ft.	6	13·3	12
Core height	ft.	6	10	10
Reflector thickness, all round	ft.	0·5	2	2 (blanket)
Reflector material	material	H_2O (light water)	graphite	—
Blanket	material	UO_2 (uranium oxide)	—	graphite + Th232
Tank I.D.	ft.	9	17·5	16·2
Tank height	ft.	33	25	25
Tank thickness	in.	8½ + 0·25 s.s.	2	2
Tank material	steel type	carbon, lined stainless	stainless	stainless
Thermal shield:				
Thickness	in.	4	6	6
Inside or outside tank	position	inside	outside	outside
Material	steel	stainless	mild	mild
Coolant:				
Substance	material	H_2O (light water)	Sodium	Sodium
Pipework, etc.	steel	stainless	stainless	stainless
Primary inlet temp.	deg. F. (deg. C.)	508 (264)	500 (260)	510 (266)
Primary outlet temp.	deg. F. (deg. C.)	542 (284)	925*[8] (496)	1,025*[8] (551)
Secondary inlet temp.	deg. F. (deg. C.)	—	470 (243)	480 (249)
Secondary outlet temp	deg. F. (deg. C.)	—	895 (480)	995 (535)
Max. pipe velocity	ft. per sec.	30	—	—
Max. velocity in core	ft. per sec.	20[10]	9	25
Pressure drop in core	lb. per sq. in.	35	6	~100[5]
Moderator cladding	material	—	Zirconium	Zirconium*
Max. temp. at coolant/moderator can interface	deg. F. (deg. C.)	—	950* (510) [9]	1,050[8] (566) [9]

NOTES ON TABLE

* Means this item is a limiting feature in the design.

[1] Simple condensing cycle would have overall thermodynamic efficiency of 26·5 per cent.

[2] Based on free uranium 235 metal at 15 dols. per gram.

[3] Construction costs increase steeply above 2,500 lb. per sq. in. design pressure. Working pressure of 2,000 lb. per sq. in., corresponding to 636 deg. F. (335 deg. C.) saturation temperature, controls both maximum coolant temperature and maximum fuel-element surface temperature.

[4] Pressure approximately atmospheric, depending upon position in circuit; gas blanket would be at a few lb. per sq. in. gauge above atmospheric to ensure no inward leak of air, pump output would be several atmospheres, etc.

[5] Approximate derived figure.

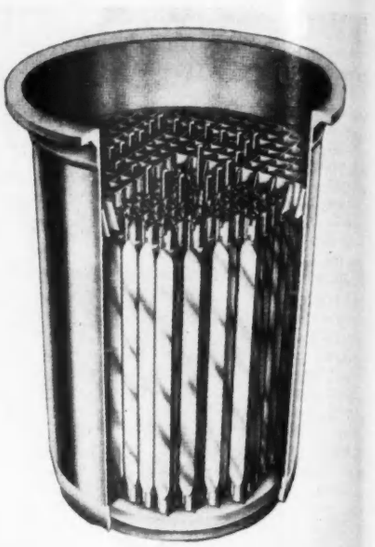
[6] Expected that this would reach unity with larger reactor.

[7] Maximum uranium temperature limited by alpha-beta change point.

[8] Present limit of performance of zirconium in contact with sodium. Maximum zirconium/sodium interface temperature at present limited to 950 deg. F. (510 deg. C.).

[9] Expected attainable zirconium/sodium performance after development period.

[10] 20 ft. per sec. in uranium 235/zirconium (U235/Zr) alloy "seed" elements, 9·8 ft. sec. in uranium oxide (UO_2) "blanket" elements.



Cut-away view of PW reactor core and pressure vessel, showing fuel-element assemblies.

POROUS MODERATOR

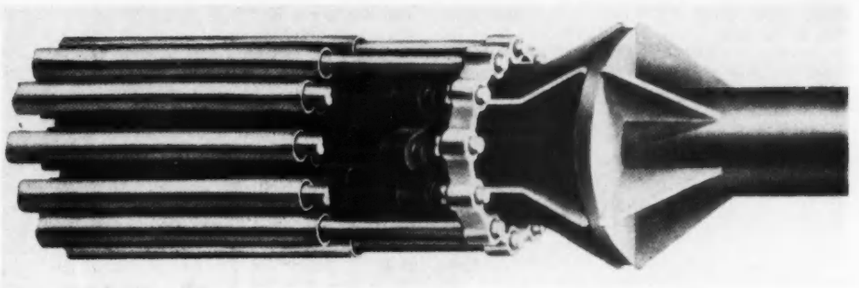
A substantial disadvantage of the sodium primary coolant is that it becomes highly radioactive during its passage through the reactor core so that it is of paramount importance to ensure that no explosive reaction between the primary coolant and other materials in and around the plant can take place in any circumstances. A first requirement, therefore, is that the heat be transferred from the radioactive primary sodium to a circuit containing non-radioactive secondary sodium. This secondary sodium can then be used to raise steam, and in the event of a failure in the steam raising plant, any resulting explosion will not disperse any radioactive material. The use of a secondary circuit does not impose a heavy thermodynamic penalty. In fact in the proposed design there is only a 30 deg. F. (16·5 deg. C.) temperature difference between corresponding temperatures in the two circuits.

Another considerable difficulty in the SG reactor is the fact that the graphite moderator is porous and therefore has to be canned in zirconium to prevent undue absorption of sodium coolant, which would result in a high wastage of neutrons on account of the relatively high thermal neutron cross section of sodium. Zirconium is chosen as the cladding material on account of its very low neutron capture cross-section combined with satisfactory mechanical and corrosion properties. Arrangements must be made for cooling the highly rated graphite moderator and in the SG design this is achieved by leaving a clearance of about $\frac{1}{16}$ in. between the moderator cans to permit an appropriate circulation of primary sodium past the cans.

CONVERSION RATIO UNITY

Whereas the maximum steam temperatures attainable with the pressurised-water design are limited by considerations of maximum practicable working pressure and surface and bulk boiling considerations, the maximum steam

(Right) Nineteen-rod fuel cluster for sodium-graphite reactor. Each rod contains 10 slightly enriched uranium fuel slugs.



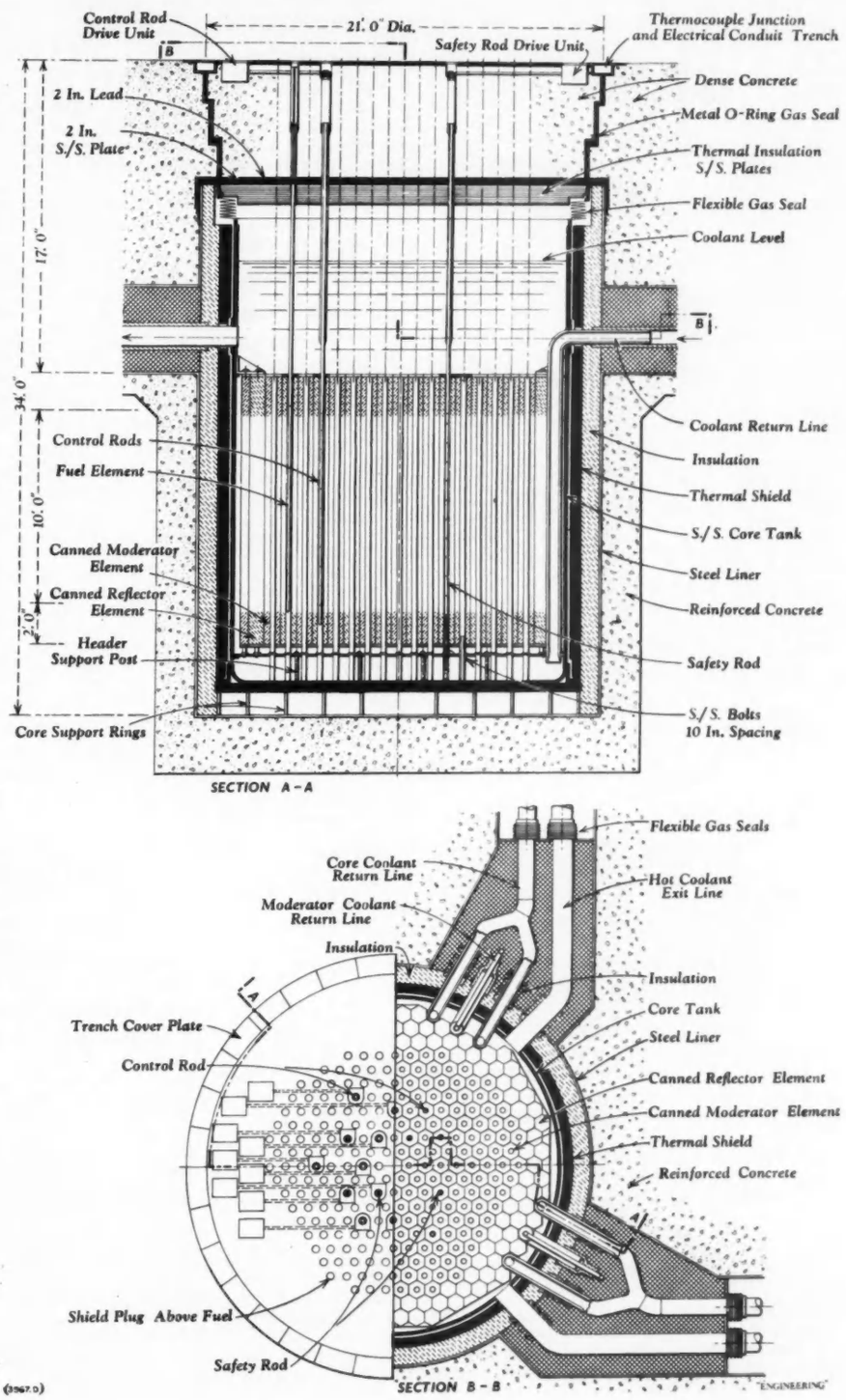
temperatures attainable in the sodium-graphite reactor are limited by the corrosion effects of sodium upon the zirconium. At the time that this design was evolved, progress in corrosion technology had indicated a maximum sodium/zirconium interface temperature of 950 deg. F. (510 deg. C.). It is worth noting in passing that if stainless-steel cladding of the moderator elements were employed, a maximum sodium temperature of 1,200 deg. F. (650 deg. C.) could be utilised now with correspondingly high thermodynamic efficiency in the heat conversion plant, but with resulting considerable losses in neutron economy. Metallurgical development work is expected to enable this limiting temperature to be raised for the sodium/zirconium combination, and in the fourth column of the accompanying table are given performance data for an SG reactor of design similar to that of the PW reactor in column three, but which exploits this expected metallurgical advance and makes use of thorium fuel elements and a thorium breeding blanket. A slightly larger reactor is expected to have a conversion ratio of unity.

The other temperature limitation in the sodium-graphite reactor is more concerned with the maximum possible specific heat output from the reactor than with can temperatures. In the case of enriched uranium fuel elements proposed for the first design, this limitation is set by the alpha-beta transformation of uranium metal at a temperature of 1,220 deg. F. (660 deg. C.) with its accompanying volume change. It was therefore decided to limit the maximum fuel element centre temperature to 1,200 deg. F. (650 deg. C.). This temperature limitation coupled with the low thermal conductivity of uranium metal, especially after prolonged irradiation, sets a limit to the diameter of fuel element which may be used for a given specific power output. It is again noteworthy that if thorium-uranium (235 or 233) alloy fuel elements are employed the maximum fuel centre temperature may be raised to 2,000 deg. F. (1,090 deg. C.), which would appear to put this reactor into the gas turbine class, although in the Geneva paper proposals this performance has been exploited in connection with a steam plant design with a resultant high overall plant efficiency of 33·6 per cent.

The choice of feedwater temperature (to the evaporators) and hence also the reactor inlet temperature for the primary coolant chosen in the two cases is of interest. In a coal-fired steam plant economy can be improved by raising the boiler feedwater temperature to about 400 deg. F. (200 deg. C.) by several stages of steam bleeding. But in a nuclear plant, which has a certain limited maximum coolant outlet temperature, this results in either less heat output for a given coolant flow or requires a larger coolant flow with correspondingly larger pumping losses, and larger steam generator costs, to which must be added the feedwater heating equipment costs. These considerations have led to the choice of 300 deg. F. (149 deg. C.) and 325 deg. F. (163 deg. C.) respectively for the SG reactor and PW reactor feedwater temperatures.

COMPACT CORE

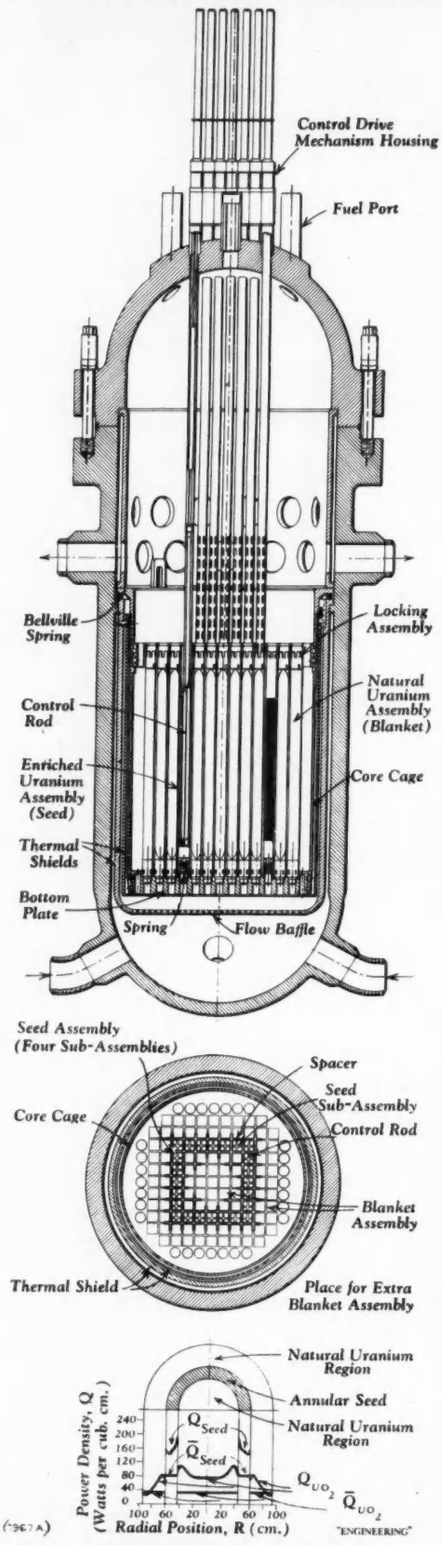
Owing to the short characteristic lengths of neutron processes in water, the core size of a light-water moderated reactor, even of such low overall enrichment as in the case of the PW design, results in quite a compact core, in this case a cylinder approximately 6 ft. high by 6 ft. in diameter. Only a correspondingly thin (about 6 in. thick) neutron reflecting layer of water is required to surround the core, so that the internal diameter of the pressure vessel needs to be only 9 ft. The corresponding pressure-vessel wall thickness for 2,000 lb. per sq. in. operation is



(Right) Sectional elevation and plan of sodium-graphite reactor, showing primary coolant inlet and outlet lines and arrangement of core.

(D567.D)

8½ in. This vessel is fabricated of carbon steel with an internal stainless-steel cladding 0·25 in. thick to deal with the difficult corrosion problems presented by high-temperature, high-pressure water. Another peculiar advantage arising from the close spacing of fuel in light-water moderated reactors is the high fast fission factor (1·08 in this case) obtained as a result of fast neutron fissioning of uranium 238.



Sectional elevation and plan of pressurised-water reactor vessel and core. Below is a diagram showing radial distribution of power density for a pressurised-water annular seed reactor using natural uranium in the form of the oxide UO_2.

It is interesting to note that in the case of the pressurised-water design it has been considered advisable to provide a thermal shield inside the pressure vessel to limit neutron damage to the vessel. This thermal shield is of stainless-steel construction and the heat generated in it by the absorption of neutrons leaking from the core is removed by the coolant flow. Being unstressed, the thermal shield does not undergo serious radiation damage. In the case of the sodium-graphite design the thermal shield, in this case required to prevent excessive heat generation in the concrete biological shield, and consisting of interlocking steel slabs 6 in. in thickness, is placed outside the coolant containing vessel, which is a stainless-steel tank about 17·5 ft. in internal diameter, and 25 ft. high. In the SG reactor the stainless-steel tank is 2 in. in thickness; in the PW reactor the stainless-steel lining of the pressure vessel is 0·25 in., to which must be added about 4 in. of stainless steel for the thermal shield. The rather surprising result, therefore, is that because of the large core volume of the SG reactor, consequent mainly upon the larger characteristic lengths for neutron processes in graphite as compared with water, the quantity of core container materials used in the construction of the low-pressure sodium-cooled reactor is somewhat more than that required in the high-pressure water-cooled design.

COMPATIBILITY

It is of interest at this point to consider the proposals for the fuel elements for the two reactors, and it will be seen that a very satisfactory degree of compatibility has been achieved in the two designs. In the case of the PW reactor the major portion (12 tons) of the uranium fuel is in the form of the dioxide which is quite inert to water at all temperatures and is manufactured by hot pressing and sintering to a high density followed by precision grinding; the fuel pellets so formed then being loaded into accurately made zirconium tubes to form fuel elements. The uranium 235-zirconium alloy fuel material is also satisfactorily inert to high-temperature water and if the bonded-on zirconium cladding of these elements should fail at any point it is not considered that there would be any serious release of radioactivity into the primary coolant water.

A similarly satisfactory situation exists in the SG reactor design. Here, the fuel elements are made of either slightly enriched uranium metal or of thorium metal alloyed with a small percentage of uranium 235 or 233. These elements are clad in stainless steel and a gap of about 0·010 in. is left between the fuel element and the can, this gap being filled with either sodium or sodium-potassium (NaK) alloy to act as a thermal bonding agent. Here again if the can ruptures, there would be no reaction between the fuel-element materials and the primary-coolant sodium although it seems likely that in this case there would be a greater release of fission products into the coolant than there would be if the can were directly bonded to the alloy fuel element as in the case of the PW reactor design. However, such a release would be of less consequence in this type of reactor because the primary sodium is in any case highly radioactive and already adequately contained and shielded.

SAFETY

With regard to safety, the major consideration in the PW reactor is the possibility of the sudden release of the stored energy of the pressurised-water circuits immediately followed by the melting or vaporisation of the fuel elements, although in the Shippingport PW reactor design the bulk of the uranium fuel is in the form of oxide (UO_2) with very high melting and vaporisation temperatures. But there are also to be considered the zirconium-uranium alloy fuel elements which would melt and vaporise at very much lower temperatures.

The melt-down or vaporisation danger also exists in the sodium-cooled design but is less likely on account of the guaranteed integrity of the core tank which is not subjected to pressure stresses, and so arranged that even if the main core tank ruptures the sodium will still be contained by the steel liner tank and concrete pit within which the reactor tank is located. The large heat capacity of the contained sodium, together with natural convection cooling should go far towards preventing this particular hazard.

PRESSURE-TIGHT BUILDING

The other major dangers of sodium cooling systems are first the possibility of a primary-sodium/oxygen reaction as a result of the fine dispersal of liquid primary sodium in air, and secondly the possibility of a direct primary sodium/water reaction as an indirect result of a failure in the steam-raising equipment. This latter risk is minimised almost to exclusion in the case of this particular plant by housing the steam generators in separate buildings well removed from the primary sodium circuits. The first danger has been met in most cases by providing a pressure containing building within which to house the reactor but this is not proposed in the case of the SG reactor. This probably enforces the remote siting of this particular reactor but, of course, considerably reduces the capital investment. This is probably the main reason for the much higher cost of the PW reactor per installed kilowatt of capacity shown in the table, for in the case of this reactor a pressure-tight building is being provided to contain any effects of the rupture of the primary circuits.

Both these well-considered power reactor designs reflect high capital costs on account of their semi-experimental nature, which includes the provision of a considerable measure of flexibility to permit the installation of alternative core designs and for the trying out of different primary and secondary loop components. In the case of the PW reactor there are very high capital costs on account of the pressure-tight building containment for the main core. Both these designs obviously have considerable intrinsic merit and it seems probable that only operating experience will reveal the advantages of one over the other.

(Mr. G. W. K. Ford is research manager in charge of experimental criticality at the Dounreay Establishment of the United Kingdom Atomic Energy Authority.)

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DISPLAY OF ELECTRONIC EQUIPMENT

Many types of apparatus were on show at a three-day exhibition staged by E.M.I. Electronics, Limited, Hayes, Middlesex. Among them were both bench and pedestal dynamic balancing machines, tape recorders and two sizes of vibrator. These last are intended for subjecting various parts to vibrations more severe than any likely to be met with in practice. The smaller has a thrust of 120 lb., and the larger one of 3,000 lb. The smaller operates over a frequency range from 20 cycles per second to 10,000 cycles per second, but has a slight falling off in the thrust value at the higher figure. The larger has two ranges, one from 1 cycle to 25 cycles per second, and the other from 300 to 950 cycles per second. Again the thrust is somewhat less at the higher ranges.

Two types of stroboscope were on display, the first being a small hand lamp with a range of 300 to 6,000 repetitions per minute. It is operated from the ordinary supply mains. The second is an instrument that is capable of illuminating four lamps simultaneously, the flashing rate being controlled by an internal oscillator. There is also provision for triggering from external sources. The internal oscillator is adjustable.

For measuring speed, there was a portable electronic tachometer, which has a range of 2 to 20,000 r.p.m., divided into four stages, with an accuracy within two per cent. The instrument is supplied with a photo-electric probe.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
"Flameproof Lighting Equipment," by J. G. Holmes. Central London Branch. Holophane House, Elverton-street, Vincent-square, S.W.1. Mon., Dec. 10, 7.30 p.m.

BIRMINGHAM
Film Evening. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham. Wed., Dec. 12, 7.15 p.m.

CREWE
"Railway Electrification," by I. Bagdzinski. Stoke and Crewe Branch. Royal Hotel, Crewe. Fri., Dec. 14, 7.30 p.m.

HALIFAX
"Electric Lifts," by Chris. Rhodes. Halifax Branch. Crown Hotel, Horton-street, Halifax. Wed., Dec. 12, 7.30 p.m.

British Institute of Management

GLASGOW
"Can Modern Techniques of Management Help Sales?" by A. Mackenzie Parkinson and Harold B. Pearson. Joint meeting with the Glasgow and West of Scotland Management Association. St. Enoch Hotel, Glasgow. Fri., Dec. 14, 7.15 p.m.

British Institution of Radio Engineers

LONDON
"Principles of the Light Amplifier and Allied Devices," by Dr. T. B. Tomlinson. London Section. London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. Wed., Dec. 12, 6.30 p.m.

GLASGOW
"Design and Manufacture of Modern Capacitors," by J. H. Cozens. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Thurs., Dec. 13, 7 p.m.

LIVERPOOL
"Automatic System for Electronic Component Assembly," by K. M. McKee. Merseyside Section. Chamber of Commerce, 1 Old Hall-street, Liverpool 3. Thurs., Dec. 13, 7 p.m.

NEWCASTLE-UPON-TYNE
"Design and Application of Quartz Crystals," by R. A. Spears. North Eastern Section. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Wed., Dec. 12, 6 p.m.

WOLVERHAMPTON
"Design of an Experimental Colour Television Receiver," by H. A. Fairhurst. West Midlands Section. Wolverhampton and Staffordshire Technical College, Wulfruna-street, Wolverhampton. Wed., Dec. 12, 7.15 p.m.

Building Centre

LONDON
Film Display exhibited by Peglers Ltd. Wed., Dec. 12, 12.45 p.m.

Chemical Engineering Group

LONDON
"Manufacture of Nitrogen Derivatives of Fatty Acids," by M. K. Schwitzer and D. Malcolm. 14 Belgrave-square, S.W.1. Tues., Dec. 11, 5.30 p.m.
"Replenishment of Underground Water Supply," by Dr. S. Buchan, Professor J. K. Baars and Dr. A. Key. 14 Belgrave-square, S.W.1. Thurs., Dec. 13, 2.15 p.m.

Chemical Society

LONDON
Tilden Lecture on "Physical Properties of High Polymers in Relation to Their Chemical Structure," by Professor G. Gee. Royal Institution, Albemarle-street, W.1. Thurs., Dec. 13, 7.30 p.m.

Combustion Engineering Association

BIRMINGHAM
"Place of the Gas Turbine in the Combined Heat and Power Generating Plant," by J. R. Needham. Midland Section. Queen's Hotel, Birmingham. Wed., Dec. 12, 10.30 a.m.

Engineers' Guild

LONDON
Annual General Meeting. Grosvenor Hotel, Victoria, S.W.1. Wed., Dec. 12, 5.45 p.m.

Illuminating Engineering Society

LONDON
"Automobile Headlamps: The I.S.O./C.I.E. International Tests and Their Influence on Meeting Beam Design," by J. H. Nelson. Federation of British Industries, 21 Tothill-street, S.W.1. Tues., Dec. 11, 6 p.m.

LEEDS
"Electrical Installation of the New Leeds College of Technology," by J. H. Gura. Leeds Centre. Lighting Service Bureau, 24 Aire-street, Leeds 1. Mon., Dec. 10, 6.15 p.m.

Incorporated Plant Engineers

BIRMINGHAM
Films on "British Tractors," presented by R. Garner. Birmingham Branch. Imperial Hotel, Temple-street, Birmingham. Fri., Dec. 14, 7.30 p.m.

GLASGOW
Discussion on "The Plant Engineer's Approach to Materials Handling." Glasgow Branch. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Mon., Dec. 10, 7.15 p.m.

Institute of British Foundrymen

LETCHWORTH
"Experiences of Forty Years in and Around Foundries," by W. Hardy. Bedfordshire and Hertfordshire Section. At the works of K. and L. Steelfounders and Engineers Ltd., Letchworth. Thurs., Dec. 13, 7.30 p.m.

Institute of Marine Engineers and Institution of Naval Architects

PORTSMOUTH
"Free Piston Engines for Marine Application," by P. Watson. Southern Joint Branch. College of Technology, Portsmouth. Wed., Dec. 12, 7.30 p.m.

Institute of Marine Engineers

LONDON
"Some Aspects of the Application of Planned Maintenance to Marine Engineering," by W. H. Falconer. Tues., Dec. 11, 5.30 p.m.*

GLASGOW
"Reheating as a Contribution to the Economy of the Marine Steam Turbine, with Special Reference to the Installation in T.S.S. Empress of Britain," by A. W. Davis. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Wed., Dec. 12, 7.30 p.m.

Institute of Metals

GLASGOW
"Metal Quality Test for Copper-Base Alloys," by A. R. French. Scottish Local Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Mon., Dec. 10, 6.30 p.m.

Institute of Road Transport Engineers

BIRMINGHAM
"Development and Operation of Disc Brakes," by J. T. Phipps. Midlands Centre. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham. Tues., Dec. 11, 7.30 p.m.

CARDIFF
"Current Trends in Fuel-Injection Equipment for Road Transport," by J. Skinner. South Wales Group. South Wales Institute of Engineers, Park-place, Cardiff. Fri., Dec. 14, 6.30 p.m.

Institution of British Agricultural Engineers

LONDON
"Tillage Equipment and Soil Conservation," by W. H. Cashmore and J. C. Hawkins. Tues., Dec. 11, 5.30 p.m.*

Institution of Chemical Engineers

BIRMINGHAM
"Heat Transfer and Pressure Drop in Packed Beds," by Professor F. H. Garner, C. W. Nutt and C. A. Le Merle. Midlands Branch. Midlands Institute, Paradise-street, Birmingham. Wed., Dec. 12, 6.30 p.m.

Institution of Civil Engineers

LONDON
Symposium on "Stabilised Soil Runways." Airport Division. Tues., Dec. 11, 5.30 p.m.*
"Conservation of Natural Resources." VI.—"Use of Waste Materials," by R. M. Finch. Thurs., Dec. 13, 5.30 p.m.*

BIRMINGHAM
"The Kitimat Story" with film, by F. L. Lawton. Midlands Association. Midland Institute, Paradise-street, Birmingham. Wed., Dec. 12, 6.30 p.m. (Admission by ticket.)

PRESTON
"Skidding Resistance of Roads and the Requirements of Modern Traffic," by C. G. Giles. North Western Association. County Hall, Preston. Wed., Dec. 12, 6.15 p.m.

Institution of Electrical Engineers

LONDON
Discussion on "Unsolved Problems Arising from Automation," opened by G. L. E. Metz. Mon., Dec. 10, 5.30 p.m.*
"B.B.C. Sound Broadcasting Service on Very-High Frequencies," by E. W. Hayes and H. Page. Radio and Telecommunication Section. Wed., Dec. 12, 5.30 p.m.*
Discussion on "The Thirteenth Edition of the Wiring Regulations," opened by Forbes Jackson. Utilization Section. Thurs., Dec. 13, 5.30 p.m.*
Discussion on "Teaching the Fundamentals of Transistor Circuits to Students of Electrical Engineering," opened by P. Godfrey. Education Discussion Circle. Fri., Dec. 14, 6 p.m.*

BELFAST
"Crystal Palace Television Transmitting Station," by F. C. McLean, A. N. Thomas and R. A. Rowden. Northern Ireland Centre. Engineering Department, Queen's University, Belfast. Tues., Dec. 11, 6.30 p.m.

CHESTER
"Control of Nuclear Reactors," by R. J. Cox and J. Walker. Mersey and North Wales Centre. Town Hall, Chester. Mon., Dec. 10, 6.30 p.m.

LEICESTER
"Transatlantic Telephone Cable," by Dr. M. J. Kelly, Sir Gordon Radley, G. W. Gilman and R. J. Halsey. East Midland Centre. College of Technology, Leicester. Fri., Dec. 14, 6.30 p.m.

NEWCASTLE-UPON-TYNE
"Conduction and Induction Pumps for Liquid Metals," by Dr. L. R. Blake. North Eastern Centre. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Dec. 10, 6.15 p.m.

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
"Design of High-Speed Cine Camera for Industrial Research," by F. A. Roberts. North East Branch. 6 Higham-place, Newcastle-upon-Tyne. Mon., Dec. 10, 7.15 p.m.

Institution of Engineers-in-Charge

LONDON
"Treatment and Disposal of Industrial Wastes," part 2 by G. B. Lewis. St. Bride Institute, Fleet-street, E.C.4. Wed., Dec. 12, 6.30 p.m.

Institution of Heating and Ventilating Engineers

BIRMINGHAM
Open Meeting. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham. Fri., Dec. 14, 6.30 p.m.

Institution of Mechanical Engineers

LONDON
"Rubber Springs for Vehicle Suspension," by A. E. Moulton and P. W. Turner. Automobile Division. Tues., Dec. 11, 6 p.m.*
Discussion on "Draft Code of Practice for Acceptance Tests on Steam Turbine Installations." Steam Group. Wed., Dec. 12, 6.45 p.m.*
"Effect of Spirit Quality on Vehicle Performance," by J. Tubman. London Graduates' Section. Thurs., Dec. 13, 6.30 p.m.*
James Clayton Lecture on "Mechanical Breathing Machines," by Captain G. T. Smith-Clarke. Fri., Dec. 14, 6 p.m.*

Institution of Production Engineers

LONDON
"Work Study and Production," by A. T. Seville. London Graduate Section. Wed., Dec. 12, 7.15 p.m.

Institution of the Rubber Industry

LONDON
Discussion on "Industrial Rayon in Tyres and Belting." London Section. 26 Portland-place, W.1. Tues, Dec. 11, 7 p.m.

Institution of Structural Engineers

LONDON
"Reconstruction at the Royal Opera House, Covent Garden," by C. H. Hockley. Thurs., Dec. 13, 6 p.m.

Junior Institution of Engineers

LONDON
Presidential Address on "Fuel Economy and Combined Heat-Electric Generation," by Bryan Donkin. Fri., Dec. 14, 7.30 p.m.

Liverpool Engineering Society

LIVERPOOL
"Manufacture of Non-Ferrous Tubes," by E. Davis. Wed., Dec. 12, 6 p.m.

Newcomen Society

LONDON
"William Strutt's Fireproof and Iron-Framed Buildings, 1793-1812," by H. R. Johnson and Professor A. W. Skempton. Institution of Civil Engineers, Great George-street, S.W.1. Wed., Dec. 12, 5.30 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE-UPON-TYNE
"M.S. Bergensfjord," by K. Haug and N. Carter. Mining Institute, Newcastle-upon-Tyne. Fri., Dec. 14, 6.15 p.m.

Prestressed Concrete Development Group

LONDON
"Prestressed Concrete Construction in Belgium," by Professor D. Vandepitte. Institution of Civil Engineers, Great George-street, S.W.1. Fri., Dec. 14, 6 p.m.* (Admission by ticket.)

Reinforced Concrete Association

LONDON
"Concrete Construction in the Soviet Union," by L. J. Murdock and others. Royal Empire Society, Craven-street, W.C.2. Wed., Dec. 12, 6 p.m.*

Royal Aeronautical Society

LONDON
"Materials for Aircraft Structures Subjected to Kinetic Heating," by Professor A. J. Murphy. Tues., Dec. 11, 7 p.m.

Royal Society of Arts

LONDON
"Engineering Electronics," by Dr. L. E. C. Hughes. Last of three Cantor Lectures. Mon., Dec. 10, 6 p.m.

Women's Engineering Society

MANCHESTER
Various short talks. Manchester Branch. International Club, George-street, Manchester. Wed., Dec. 12, 6.30 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
British Institute of Management, Management House, 8 Hill-street, London, W.1. (GROsvenor 6000.)
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chemical Engineering Group, 16 Belgrave-square, London, S.W.1. (BELgravia 3647.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Combustion Engineering Association, 6 Duke-street, St. James's, London, S.W.1. (WHItehall 5536.)
Engineers' Guild, 78 Buckingham-gate, London, S.W.1. (ABBey 7315.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Metals, 17 Belgrave-square, London, S.W.1. (BELgravia 3291.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institution of British Agricultural Engineers, 6 Buckingham-gate, London, S.W.1. (TATe Gallery 8582.)
Institution of Chemical Engineers, 16 Belgrave-square, London, S.W.1. (BELgravia 3647.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Engineers-in-Charge, 100 Earlsfield-road, London, S.W.18. (BATtersea 1394.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Naval Architects, 10 Upper Belgrave-street, London, S.W.1. (SLOane 4622.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of the Rubber Industry, 4 Kensington Palace-gardens, London, W.8. (BAYswater 9101.)
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool, 2. (Central 3717.)
Newcomen Society, Science Museum, Exhibition-road, London, S.W.7. (KENsington 1793.)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne 1. (Newcastle 20289.)
Prestressed Concrete Development Group, Terminal House, Grosvenor-gardens, London, S.W.1. (BELgravia 6661.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Women's Engineering Society, 25 Foubert's-place, London, W.1. (GERrard 5212.)

TESTING TALL STRUCTURES

A testing station for tall structures—up to 140 ft. high or more—has been established in a disused quarry at Wirksworth, in Derbyshire, by Stewarts and Lloyds, Limited. By taking full advantage of the peculiar advantages of the site, as illustrated in Fig. 1, it will be possible to conduct tests on such structures as transmission towers and crane jibs under more favourable conditions than has been possible hitherto. Although the station has been set up for the benefit of Stewarts and Lloyds' subsidiary, Tubewrights Limited, to assist in the development of tubular structures, the company are open to consider requests from other organisations wishing to conduct tests. The company's general manager of research, to whom requests should be addressed, is at Corby, Northamptonshire.

The site itself is a disused limestone quarry which has a nearly rectangular floor of 100 ft. by 60 ft. and is surrounded on all four sides by vertical walls about 150 ft. high. It is entered through a narrow cleft which runs the full height of one face. The "Monkey Hole," as it is called, has the advantage of being secluded but it is readily accessible by road, and the cleft entrance is sufficiently wide to enable components of all structures likely to be tested to be taken in. Erection of the structure is simplified by a pulley tackle slung above the centre of the floor by ropes crossing the quarry at cliff-top height. For transmission towers, the maximum width across the arms is limited to 50 ft. for towers up to 100 ft. in height, but above this height considerably greater widths can be accommodated. For towers taller than 140 ft. advantage could be taken of rising ground behind the quarry for anchoring load lines.

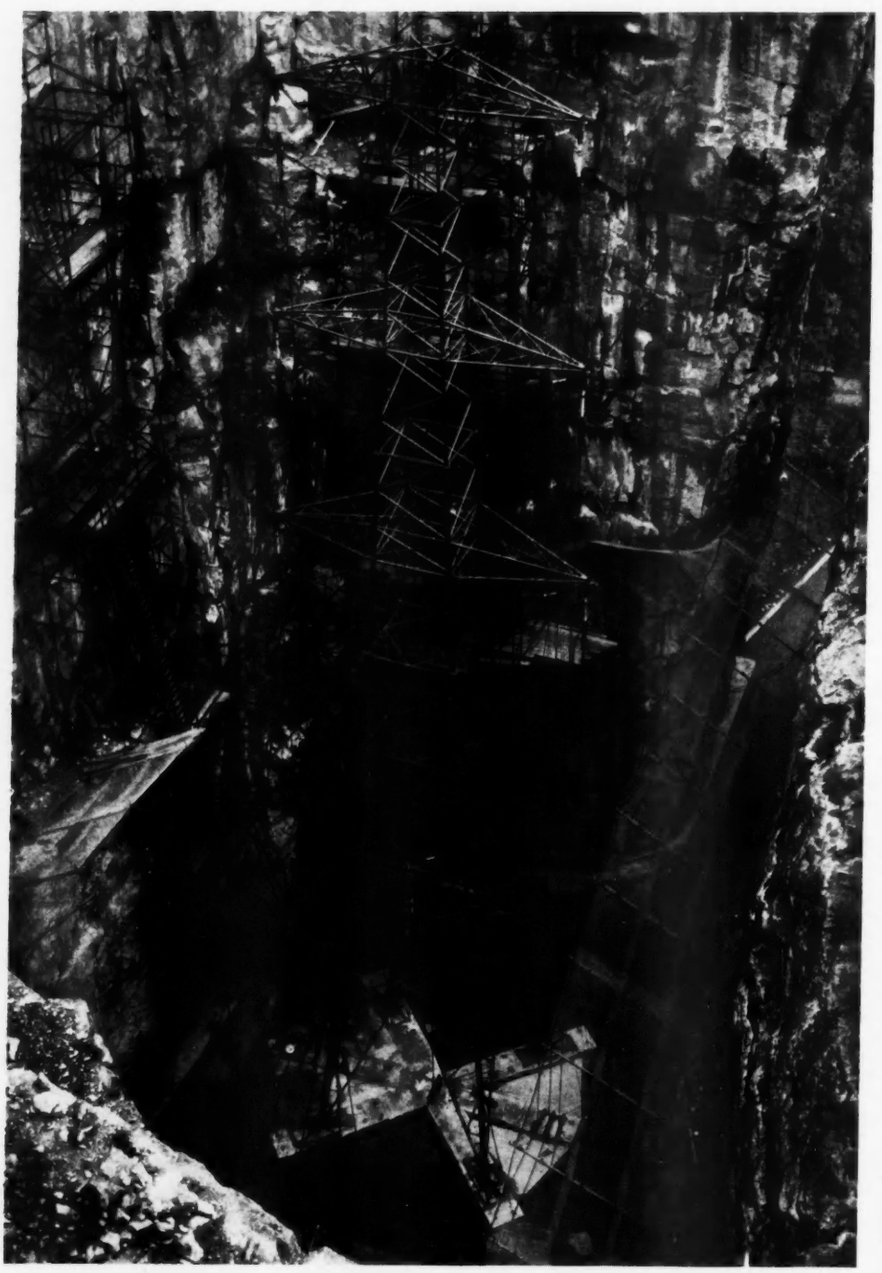

Fig. 1 A testing station for tall structures has been established in a disused quarry where the walls make loading arrangements relatively simple. Protection is also obtained against unknown wind loads.

For tests on such structures, it is desirable to apply a vertical load and two horizontal loads at right angles at selected points of the framework and simultaneously eliminate all unknown forces —particularly wind loads to which the structure is likely to be subjected if the test is carried out in the open. The test loads are selected and applied to the structure in such an order as to conduce stress conditions at least as bad as those likely to be met in practice; for a transmission tower, for example, this may well occur when one or more of the lines has been broken and the remainder are covered in ice (so increasing both their weight and diameter) and the whole is subjected to a high wind. It will be realised that to make similar tests in the open—as has been necessary hitherto in the United Kingdom—it has been necessary to rig at least two additional loading towers as tall as, and stronger than, the structure under test. Moreover, it was essential that tests should only be conducted when there was little wind about, so that unknown forces were eliminated. Consideration of these facts makes clear the advantages of the Wirksworth site, which enables tests to be made almost as if inside a building: four walls are available to anchor load points, full protection is given against the wind and, as may be discerned from a careful study of Fig. 1, access to the test area is available at floor level, directly from the road outside, through the cleft to be seen on the right of the illustration. A testing site with some of the advantages of Wirksworth has been in operation for some years near Milan, Italy; it belongs to the Societa Anonima Elettrificazione and was described in ENGINEERING for February 20, 1953, page 225, and some tests undertaken there on behalf of Stewarts and Lloyds were described in the issue of November 27, 1953, page 679.

SITE ARRANGEMENTS

At Wirksworth a universal base has been laid down on the floor of the quarry so that a large variety of towers can be tested. As may again be seen from Fig. 1, this consists of two diagonal concrete floor pads into which have been embedded 14 holding-down bolts; any form of tower can be adequately fastened to the foundation by easily fabricated footplates drilled to fix over the holding-down bolts. Transversely across the base is a third ground pad to which have been fixed the shackles used to re-direct the load lines to winches in the control house located on the floor of the quarry—below the cliff face in the foreground of Fig. 1.

For horizontal loading of the arms of the transmission towers, the load lines are taken over shackles anchored at the appropriate height in the quarry walls, thence to the shackles on the floor of the quarry and so to the winches. The anchors consist of eye bolts and have been proved to withstand a direct pull of 94 tons, at which load it is found that the eye of the anchor breaks rather than the anchor itself being disturbed in its rock setting. Moreover, as these shackles are used to re-direct the load, the resultant pull is more usually at an angle of 45 deg. to the line of the anchor, so that premature failure of the anchor is not a serious possibility. In general, it is not thought that the loads will exceed 30 tons and, as the tests proceed, anchors will be installed as they are required; ultimately, there are likely to be sufficient anchors in position to allow any structure to be tested, making use of a brindle spanning across two anchors if the need arises.

In planning the station, 12 simultaneous loading points have been catered for by installing this number of winches, each capable of a 5 ton pull. The usual arrangement of multi-sheave blocks enables this pull to be magnified up to the desired maximum of 30 tons. Electric motors of 2 h.p. and running off the mains at 960 r.p.m. are used to drive the winches through gears which reduce the drum speed to $\frac{1}{2}$ r.p.m., equivalent to a rope speed of $1\frac{1}{4}$ ft. per minute;

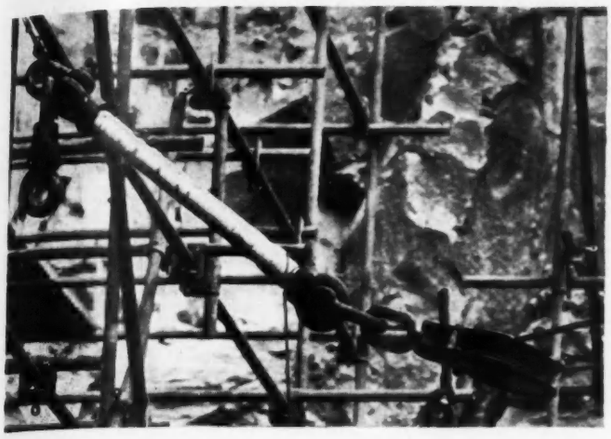

Fig. 2 (left) The pullmeter which is used for measuring the tension in the loading lines. It is available with capacities of 2, 5, 10 or 30 tons.

the multi-sheave blocks further reduce the rate at which the load is applied to the structure. Should more than 12 loading points be required, one winch can be used to serve several points at the same time; alternatively, loads in excess of 30 tons can be obtained by coupling winches and anchor points together.

MEASURING DEVICES

The loads applied to the structures are measured by "pullmeters" which have been developed in the form used by Stewarts and Lloyds' department of research and technical development. A pullmeter ready for use is shown in Fig. 2, and the principle of operation is shown in Fig. 3. The load is actually carried by a steel tube and the extension of the tube under load is measured by a small differential transformer, the coils being mounted from one end of the tube and the core—of iron laminations—from the other. The coil consists of three independent parts of which only the centre one is energised. As the load is changed, the core moves within the coils, causing the magnetic flux in the system to be changed, and a signal is sent back to the control room where it is amplified and thrown up on a dial reading directly in tons.

The pullmeters have been made in four sizes, with capacities of 2, 5, 10 and 30 tons. Experience has shown them to be waterproof and robust; they are readily calibrated (and are checked periodically at the station by a dead-weight test). Sensitivity is one part in 1,000 of the full capacity load and errors have not been found to exceed more than plus or minus 1 per cent. By locating the pullmeters just behind the loading point the actual applied load is measured, any stretch or friction in the load line being eliminated from the measurement.

The deflection of the structure at any point is conveyed by a wire which, passing over a pulley system, leads down to a transmitting instrument standing on the quarry floor, the wire being kept taut by weights which hang on it within the tubular body of the instrument. A slot in the wall of the tube enables a direct visual reading to be made of the movement of the weight and therefore of the deflection of the structure. The wire has also been given one turn round the drum of a potentiometer which is used to vary an electrical signal sent back to the control room, where the deflection is shown on a dial gauge marked off in inches. The sensitivity of the apparatus is such that a movement of 0·05 in. is detectable, and the accuracy of the readings to within about 0·1 in.; the full-dial reading of the gauge is 10 in., which is of the same order as the maximum deflections to be measured frequently, but greater deflections can be considered by noting the completed revolutions of the pointer. Arrangements have been made for ten deflections to be measured.

The building which houses the winches and switchgear extends across the end wall, opposite the cleft entrance; the control room is built into the upper storey of this building. The winches are under push-button control from the control room, with master cut-out switches located at several other places so that loads can be released in an emergency.

The main control desk has two wings, each wing controlling six winches and carrying a board which supports six dial gauges recording the loads measured by the pullmeters and five recording deflections. Each dial is labelled and each board bears a brief description of the test and the stage reached. Cameras are used to photograph each board when steady conditions have been obtained at any given load. Direction of the tests is simplified by the use of a loudhailer and field telephones allow communication between vantage points and the control room. A tape recorder is also available to record the general progress of the test and any commentary made by the engineer in charge.

Although the station has been equipped in the first instance primarily to record loads and deflections of the frames, auxiliary apparatus includes resistance strain gauges by which stresses at appropriate points on the structure can be recorded, either during static tests or under vibrating loads. Photographs of the structure can be taken during the test, and a detailed inspection of the structure can be made through telescopes. Records are also being kept of the prevailing air temperature and of weather conditions.

Though the first tests have been limited to transmission towers—that shown in progress in Fig. 1 is being made on a 275 kV tower for the super grid—there is of course no reason why

Fig. 4 The deflection transmitter. A taut wire from the structure actuates a potentiometer which varies the signal passed to the control desk where deflections are shown on a dial gauge. The wire also moves a marker which travels up and down the tubular body of the transmitter.

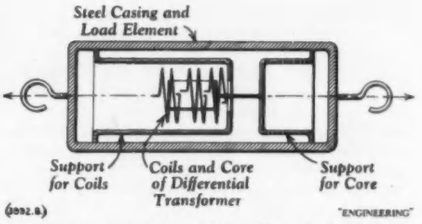

Fig. 3 The principle of the pullmeter depends on measuring the extension of the tubular casing under load, using a differential transformer.

any other sort of tall frame or mast should not be subjected to examination, taking advantage of the equipment which has been installed. Loading arrangements are sufficiently adaptable that they can be made to suit nearly any size of structure and the loads could be large enough to carry the test through to destruction. The almost ideal formation of the site should make tests of this type both easier to undertake and more satisfactory than hitherto.

* * *

UNDERWATER TELEVISION CAMERA

Pye, Limited, Cambridge, have made an addition to their range of underwater television cameras. It is an all-purpose model able to operate down to a depth of 3,000 ft. It can be hand-held by a frogman or diver, suspended from or trawled by a ship, or fitted to an underwater vehicle. This is the second spherical underwater T.V. camera produced by Pye. The first was a smaller, hand-held model, using a Staticon pick-up tube and designed for use down to 250 ft.

The image orthicon pick-up tube makes the new camera suitable for use under conditions of low contrast, and especially for all types of salvage operation. It can be fitted with two handles for use by a frogman or diver, with fins and lamps for trawling, or with a gimbal ring when it is to be used in an underwater vehicle. It employs one wide-aperture lens with remote servo focussing and switched motor aperture control. Other standard features include a depth indicator, housed within the camera casing, which gives observers on the surface readings of the depth at which the camera is operating. Provision is also made within the camera casing for the attachment of an underwater loudspeaker microphone and two additional lamps. An outlet is provided for the supply of power to panning and tilting motors.

The camera container consists of two Duralinox hemispheres held together entirely by external air or water pressure to form a sphere 19 in. in diameter. The action of forcing the two halves together by means of a hand tool, pushes air through a release valve and creates low internal pressure. Although it is intended for operation down to a depth of 3,000 ft., to provide an adequate safety margin the casing has been designed to withstand a water pressure of 1,500 lb. per sq. in., corresponding to a depth of 3,900 ft. It is 1½ lb. positively buoyant in water and weighs 117 lb. in air.

The standard equipment includes a 14 in. picture monitor and camera control unit, which may be on board ship or at any other convenient location above the water; all camera adjustments are carried out from the control position. The 14 in. monitor is self-contained and large enough to be viewed by a number of people at a distance or used for the close examination of fine detail; if necessary, additional monitors may be used.

A clear-water container can be attached to the viewing port of the camera, enabling an increased range to be obtained in turbid water. This device is a glass-ended metal cone, filled with clear water, which, when fitted in front of the camera lens gives a much larger viewing area in cloudy water. It is available in three sizes, up to 6 ft. long.

ATOMIC REVIEW

Power in a Package

Catching up on overseas news—American reactors —Packaged power—More about advanced reactors —Site for third C.E.A. nuclear power station— Graphite project—Blood and radiation.

Since the beginning of October, when the opening of Calder Works drew wide attention to Britain's nuclear achievements, we have tended to concentrate on events at home. We hope to remedy the consequent neglect of news from overseas by publishing from time to time during the next few weeks articles dealing mainly with developments abroad. Initially we shall be concerned with the United States. We shall, of course, continue to deal with important home news.

The number of reactors completed, building, dismantled, planned or under consideration in the United States is said to amount to 140, including 109 civilian reactors, reactors built for countries overseas, ship and submarine prototypes and 15 reactors for the U.S. aircraft nuclear propulsion programme. Among these are a number of portable reactors and we refer to some of these below.

Portable Reactors

A portable atomic plant which can be carried by air, assembled and, it is claimed, put into operation in three days, is being built by the Glenn L. Martin Company in Baltimore, Maryland. The plant, weighing only 24,000 lb., is said to be capable of producing enough electricity for a city of 10,000 people for 18 months without refuelling. The entire unit—nuclear reactor with fuel, generating equipment and maintenance building—is packed in eight crates or " pods " of stuctural aluminium, the largest of which measures 9 ft. by 9 ft. by 30 ft. Fuel is in the form of tubular elements of slightly enriched uranium, of which there are more than 5,000, and regulation is by means of control rods. The core is water cooled, the water providing steam for power generation. The reactor is to be made in models ranging from 500 kW to 5 MW and one under construction for the Dominican Republic will have an output of 1 MW. The cost of the portable reactor, less the generating plant, will be under a million dols. It has been designed for operation in remote areas, where competitive power costs are very high. The core of the reactor is shown in Fig. 1.

Earlier this year (July 6, page 30) we referred to the 2 MW pressurised-water Army Package Power Reactor (APPR) which Alco Products, Incorporated, of Schenectady, are building at Fort Belvoir, Virginia, for the U.S. Army and Atomic Energy Commission. It is to be completed early in 1957. Fig. 2 is an overhead view of a pressurised-water reactor core similar to the APPR unit, showing the core structure, fuel elements and control rods. It has been undergoing criticality experiments at the company's new criticality facility in Schenectady. Alco expect to have ready in the next two years a 10 MW unit costing about 3½ million dols. for mining and other isolated concerns. Mr. K. Kasschau, atomic energy manager of Alco, speaking at a recent five-day power-reactor conference in Belgium, said that in the early period of atomic power development the package reactor had an important part to play. In the case of larger nuclear plants as much as seven years were required from initial concept studies to the starting of a second improved project embodying the lessons learned from the first; whereas the APPR plant would have taken only three years to complete from initial concept to the generation of power. Alco have recently published a 12 page illustrated bulletin giving details of their work on nuclear reactors. It includes a 5 page set of superimposed transparent charts showing a pressurised-water reactor plant, and a heat balance diagram of a typical Alco nuclear power design.

HOME NEWS

Advanced Reactors

The conference on advanced reactors (see page 725) held at Harwell for representatives of British industry revealed a number of outstanding problems. In the development of the sodium-graphite system considerable work remained to be done on fuel elements, the design of the heat-transfer system and on protecting the graphite against liquid sodium. The homogeneous aqueous reactor presented problems concerning the continuous processing of the fuel and the handling of the blanket slurries. Similar difficulties might occur with regard to the liquid-metal fueled reactor, for which in addition it would be necessary to develop an impermeable graphite moderator; alternatively a beryllium moderator might be used. In the case of the fast reactor metallurgical investigations remained the major outstanding task. The Atomic Energy Research Establishment is also investigating possible propulsion reactor systems in collaboration with the British Shipbuilding Research Association. One of the most promising of these systems, the organic-liquid moderated reactor, is being looked at also as a candidate for power reactors, with outputs between 10 and 30 MW of electricity, for the export market. It has been pointed out that one of its principal advantages is the low pressure and higher operating temperature, compared, with those of the pressurised-water reactor. The corrosion problems involved should be less severe than in other liquid systems and the rate of deterioration of possible organic liquids under irradiation is not sufficiently fast to make the system uneconomic.

Third CEA Nuclear Station

A site at Inkley Point in Somerset, 4 miles west of the mouth of the River Parrett has been chosen for the site of the third Central Electricity Authority nuclear power station. It is expected to be completed in three years.

Reactor Graphite

A factory is to be built on Tyneside for the manufacture of high-density high-purity graphite for use in nuclear reactors. For this purpose C. A. Parsons and Company, Limited, A. Reyrolle and Company, Limited, Sir Robert McAlpine and Sons, and Clarke Chapman and Company, Limited (members of the Nuclear Power Plant Company) in collaboration with the Great Lakes Carbon Corporation of New York are forming a British company to be called Anglo Great Lakes Corporation Limited. The anticipated cost of the whole project is £6 million and construction work is expected to begin early next year.

Postscript

The discovery made by Dr. J. F. Loutit and his colleagues of the Medical Research Council unit at Harwell, that, contrary to accepted beliefs, a mammal, after irradiation, might assimilate by transplantation complete cells from a different (though perhaps related) mammal, appears to have considerable practical significance. The prospect of replacing blood-forming tissues, damaged by radiation, with injected bone-marrow cells from an alien source (which the team showed to be possible) raises in the mind of the layman an interesting question. Reference has been made to leukaemia—a disease of the blood-forming tissues that can arise from excessive exposure to radiation. Is it not also possible, since the damaging effect of radiation on blood formation can apparently be remedied, that a greater range of radiation intensities can be tolerated in the treatment of cancer? Whether or not this question is valid, there would clearly be many more questions to be answered before such an approach could be used for human beings. Of related interest is the report that the incidence of leukaemia in the United States has increased by 70 per cent. in the last 10 years. It would be interesting to hear an explanation of this, since it presumably cannot be accounted for simply by increased efficiency of diagnosis.

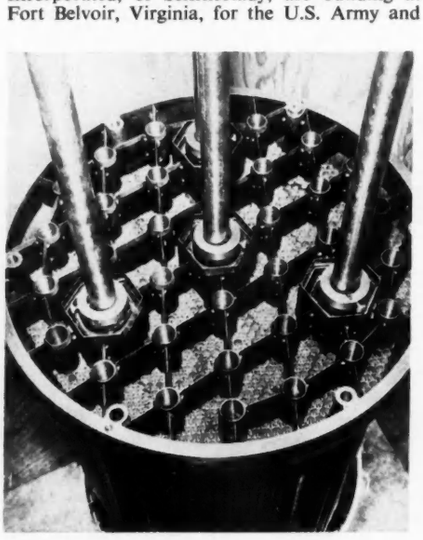

Fig. 1 (left) More than 5,000 tubular elements of slightly enriched uranium provide the fuel for the Martin portable power reactor, which is water cooled, and together with generating equipment can be packed into eight 30 ft. crates.

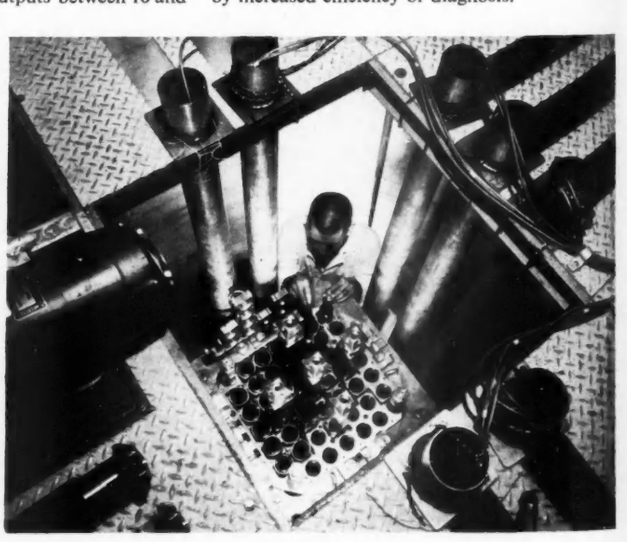

Fig. 2 (right) Pressurised-water reactor core similar to that for the 2MW Army Package Power Reactor (APPR) being built by Alco at Fort Belvoir, Virginia. It has been undergoing criticality experiments.

In Parliament

COMMONS FOLLOW THE LORDS

As has been the case since the beginning of the present parliamentary session, the international political situation continued to be the main centre of interest in the House of Commons throughout last week, although, even so, time was found there for the consideration of a number of matters of technical and commercial consequence.

For example, on November 27, a Bill was presented by the Minister of Fuel and Power, Mr. Aubrey Jones, and other members of the Government, to provide for the dissolution of the Central Electricity Authority and the establishment of a Central Electricity Generating Board and an Electricity Council, and for the transfer of functions of the C.E.A. to that Board and Council or to the Minister of Fuel and Power. The Bill was read for the first time on that day.

Leave was given to Mr. Graham Page (Conservative) to bring in a Private Member's Bill having for its aim the abolition of the need for endorsement of some 97 out of every 100 cheques drawn. Nearly two years ago, Mr. Page was given permission to introduce a similar Bill, but that Bill came to an end with the end of the last Parliament. In the meantime, a committee was set up by the then Chancellor of the Exchequer and has since reported that, in its opinion, a substantial saving of unproductive work would be achieved, and the present banking system would be appropriately adapted to modern conditions and needs, if it were arranged that endorsement was no longer necessary on cheques being collected by a bank on behalf of a customer who was the payee.

The present Bill will endeavour to make certain that a paid cheque is as good *prima facie* evidence of the receipt of payment as a formal receipt signed, where appropriate, over a two-penny stamp. It will also seek to alter the Truck Act to permit the payment of wages by cheque. Altogether, a Bill of outstanding importance to all branches of commerce in the United Kingdom. It will be read a second time on February 1 next year.

Among those who were successful in the ballot for Private Members' motions, to be debated on December 14 next, was Mr. Ellis Smith (Labour). He has decided to call the attention of the Commons to the need to increase the number of scientists, technologists and engineers, and to move a resolution thereon. Aspects of this subject were discussed at some length in the debate in the House of Lords on "Engineering and Scientific Education" on November 21 last. A report of the speeches then made was given in last week's "In Parliament," page 703. Reference was also made in "The Human Element" on page 704, in the same issue.

Although, in this instance, the Commons are following in the steps of the Lords, the debate in the lower House is likely to be on a somewhat wider basis, and, consequently, of no less interest than that in the upper Chamber. Then, too, there will probably be more emphasis on the strictly trade-union points of view.

LONDON TRAVEL BY HELICOPTER

Problems arising from the use of helicopters for inter-city travelling purposes were raised by Mr. N. N. Dodds (Labour/Co-operative). He pointed out how important it was that early decisions should be made with regard to landing sites in London on, or in the vicinity of, the River Thames, and inquired of the Minister of Transport and Civil Aviation as to what consideration had been given to that aspect of the matter.

In reply, Mr. John Profumo, the Ministry's Joint Parliamentary Secretary, said that little further progress could be made without more knowledge of the operational and economic characteristics of the twin-engined helicopters now being developed. The Minister of Transport was studying, in conjunction with the chairman of the British European Airways Corporation, how best to obtain this information. The South Bank air station would remain "on call" until such time as the site would be required for development, but little use had been made of its facilities since the scheduled services of the B.E.A. came to an end.

A design for a floating platform to accommodate single-engined helicopters had been discussed with the Port of London Authority and the London County Council, but the demand so far received had not justified the Ministry in putting this costly project in hand. It was known that there was general interest in the matter, but, said Mr. Profumo, it would not be right for the Government to spend large sums of money on a permanent air station for London until more was known regarding how much space was required and what the other characteristics of the undertaking would be.

OVERLOADING OF SHIPS

Evidence produced by Mr. Harold Watkinson, the Minister of Transport, in regard to the overloading of ships inspected in British ports showed that there has been a very definite rise in the number of convictions and maximum fines, during the past year, for this class of offence. According to information given by him to Mr. S. Knox Cunningham (Ulster Unionist), 54 ships were found to be overloaded in United Kingdom ports during the twelve months ended September, 1953, for which 14 convictions were recorded. In only one of these cases, however, was the maximum fine imposed.

In the following twelve months, ended September, 1954, there were 46 cases, in respect of which 13 convictions were recorded and maximum fines were imposed on three occasions. During the corresponding period, ended September, 1955, the number of cases declined to 31, with 12 convictions and two instances of maximum fines being imposed.

Although there was some increase in the number of cases brought to light during the twelve-monthly period ended in September last, the total was still only 42, but the number of convictions was increased to no less than 19. Even more striking was the fact that maximum fines were imposed on no fewer than seven occasions, more than during the preceding three twelve-monthly periods combined.

IRON AND STEEL REALISATION

Some particulars of the progress made in connection with the de-nationalisation of the iron and steel industry were given by Mr. Harold Macmillan, the Chancellor of the Exchequer, to Mr. G. R. Strauss (Labour). About one-quarter of the steel production of the companies owned by the Iron and Steel Corporation, he said, now remained in the hands of the Iron and Steel Holding and Realisation Agency.

The total amount of compensation stock originally issued was £245·8 million. The Agency took over from the Corporation securities which cost the Corporation £252·3 million, as well as certain loans and obligations. Together, these brought the total of investments and obligations inherited to £364·2 million. In addition, the Agency had made further investments, thereby bringing the cumulative total of the Agency's investments and obligations to £429·9 million.

The net total of the investments and obligations remaining with the Agency at September 30, 1956, was £226·4 million, and, since that date, proceeds from the disposal of six companies had amounted to £1,250,000. Further details would be made available in the third annual report of the Agency, which would be published shortly.

Facilities for Large Oil Tankers

Commander J. F. W. Maitland (Conservative) asked the Minister of Transport about the provision of facilities for the largest types of tankers now being constructed. In reply, Mr. Watkinson said that the oil companies and the other interests responsible for providing facilities were well aware of the present trends in tanker construction and, he understood, planning developments to meet them. As to the case of Milford Haven, to which Commander Maitland made reference, his Ministry had already taken a lead in helping to bring the various parties together.

In reply to Sir J. R. H. Hutchison, Bt. (Conservative), who inquired about the port facilities for tankers with a deadweight of 35,000 tons and 70,000 tons, respectively, Mr. Profumo said that there were facilities for discharging loaded tankers with a deadweight capacity of 35,000 tons at Finnart on the Clyde, at Fawley, at the Isle of Grain, at Thameshaven and at Coryton. There were, however, at present, no ports capable, without modification, of discharging a fully-loaded tanker of 70,000 tons.

Production of P.1. Aircraft

In reply to Mr. R. R. Stokes (Labour), who desired to know what progress was being made in the construction of the new P.1 military aircraft, Mr. Ian Harvey, Parliamentary Secretary to the Ministry of Supply, said that a development batch of 20 of these aircraft was ordered in February, 1954. Their delivery, he said, should begin within the next twelve months. Materials and jigs and tools for production aircraft of this type had been ordered in November, 1955. An initial production order had now been placed, but it would not be in the public interest to disclose its size.

Dounreay Fast Breeder Reactor

Construction work on the fast breeder reactor, at Dounreay, in the North of Scotland, is proceeding according to plan and is now two-thirds completed. According to an answer by Mr. R. A. Butler, the Lord Privy Seal, to Mr. Hector Hughes (Labour), there were 646 workpeople of the United Kingdom Atomic Energy Authority employed at Dounreay, as well as about 1,500 persons working for contractors. In addition, there were 250 contractors' employees working off the site, engaged for example, on such matters as housing development.

Oil Shortage Effects on the Steel Industry

Information as to what steps the President of the Board of Trade was taking to ensure that the steel industry received adequate supplies of fuel oil, was sought by Mr. A. M. F. Palmer (Labour/Co-operative). Mr. F. J. Erroll, the Board's Parliamentary Secretary, told him that arrangements were being made for the steel industry to obtain additional supplies of creosote pitch to make up for the 10 per cent. reduction in their supplies of fuel oil. It was expected that, by this means, output could be maintained and any reductions in employment avoided.

Synthetic Rubber Production

Mr. Erroll informed the House that the production of synthetic rubber on a commercial scale in this country had not yet begun. Two special-purpose synthetic rubber plants, with a total capacity of 14,000 tons a year were expected to be in commercial production early next year, and a third such plant by the following summer. He told the Revd. R. W. Sorensen (Labour), who raised the matter, that the production of general-purpose synthetic rubber was expected during 1958. The plant required for synthetic rubber production was necessarily of a complicated nature and it was for the operators themselves to develop it.

In reply to a question by Mr. S. S. Awbery (Labour), who asked about the impact of the production of synthetic rubber on Britain's trade with Malaya, Mr. Erroll said that it was not expected that Malayan exports of natural rubber would be adversely affected by the consumption of the synthetic product in this country. World demands for natural rubber were sufficient to absorb all supplies. Retained imports of natural rubber into the United Kingdom rose steadily during the three years 1953 to 1955, in spite of a sharp increase in imports of the synthetic product.

THE HUMAN ELEMENT

Engineers' Guild offers contributory pensions scheme—Transport Minister forms committee to stagger London's working hours—Events combine to cause short-time working in the car industry—Wage demands may further endanger Britain's economic position—Security becomes a feature of union demands—Non-profit scheme to organise "hire-purchase" holidays.

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Pensions Without Ties

The Engineers' Guild have brought out a new form of group insurance which should go far to solve the problems faced by professional engineers who wish to provide adequate pension arrangements for themselves and their families. The scheme is designed to enable the professional engineer to make arrangements for death cover or pension which will be independent of the continuity of his employment in any one organisation, or, if self-employed, which will benefit from the lower rates open to group schemes. No longer need pension considerations deter engineers from "striking out into new fields to widen their experience and to gain opportunities for using their abilities to the full." Conversely, companies will be freed from the difficulties of fitting older, experienced engineers into existing group pension schemes.

Various features of the scheme combine to make it attractive, especially to the young engineer who wishes to gain experience with several firms before settling down. The employer can pay all or part of the contributions as he wishes; all contributions qualify for income tax relief; individual evidence about health is not required for the first £2,000 insured; and the age at which a pension is payable can be selected (within certain limits). It would thus seem to offer all the advantages of company-run schemes without any of their disadvantages.

The scheme is open to members of the Guild, or to those eligible for membership—namely, members of the Institutions of Civil, of Mechanical and of Electrical Engineers aged between 21 and 60. The details are simply and clearly set out in a booklet *Pensions for Professional Engineers*, published by the Engineers' Guild Limited, 78 Buckingham-gate, London, S.W.1.

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Staggered Hours

The fuel crisis has given renewed impetus to attempts to further the staggering of working hours in Central London. The Minister of Transport, Mr. Harold Watkinson, has set up a new committee to consider what immediate measures can be taken. The committee, under the chairmanship of Mr. John Fitzgerald—chairman of the Transport Users' Consultative Committee for London—will be a permanent one and will report progress to the Minister at least once a year. It is the third attempt to solve this difficult problem. In 1947 and 1948 a campaign was conducted by the Ministry of Transport but any achievements made were lost in the post-war increase in employment in Central London. The second campaign started in 1954, and some useful results were achieved through enlisting the co-operation of employers in the area. But, according to the Ministry of Transport, "a very great deal requires to be done before there can be any substantial reduction of the serious congestion that exists in public transport at the peak hours."

The new committee will have teeth; it will be "more executive than advisory," will "consider and set in train further measures for the staggering of working hours, "will review changes in the day-time population" "particularly those arising from the erection of new buildings," and, finally, will recommend to the Minister "any measures which it may consider desirable but find itself unable to initiate." This suggests that the new committee will have the full backing of the Government in doing or getting done something positive about the situation.

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Hard-Hit Car Workers

The car industry, and the people who work in it, are having all the bad luck. First the hire-purchase restrictions and the credit squeeze, then—almost simultaneously—the import restrictions in its best export markets in Australasia, and now the Suez crisis and petrol rationing.

Short-time working is spreading fast. Last week Jaguar cars announced that overtime will be stopped and a four-day week introduced, for the first time in the company's history. Until now they have been increasing output and recruiting skilled workers laid off by other companies. The 50 per cent. increase in output planned for this year, and almost achieved, is to be abandoned and current output cut by up to one third. Notice has been served on 9,000 of Ford's 20,000 Dagenham employees that they will start a four-day week, and also to some of the 17,000 employees of Briggs Motor Bodies. Vauxhall will have to reduce the working week to three days in some sections of their factory. Rolls-Royce motor-car division at Crewe has stopped all overtime.

The bright spot in this depressing situation is the much increased demand for Morris Minors. Output is to be stepped up from 1,700 to 2,000 a week and overtime will be introduced to make this possible.

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Mounting Tension of Pay Claims

The rejection last week of the engineering unions' claim for a 10 per cent. wage increase was expected and had been predicted by the employers even before the claim had been formulated. A similar outcome is thought likely when a decision is reached on claims submitted by the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, the building workers and others. The kind of trouble that lies in store for the country was foreshadowed by the reaction of the London busmen to the offer of 5*s*. a week increase in reply to their demand of £1. The negotiating committee have been granted "plenary powers to press the claim by the Transport and General Workers' Union."

The Suez crisis has affected the situation much more than is yet fully apparent. The railwaymen's bargaining power has been strengthened and that of the road haulage workers weakened. The mining unions have just resumed negotiations with the National Coal Board on their demand for the removal of disqualification of the bonus shift payment, with the knowledge that the country cannot afford even a temporary stoppage in coal production and that an increase in output is urgently needed. On the other hand, the shortage of oil may lead to shut-downs in industry, and already has resulted in short-time working and redundancy in road haulage, garages and motor-vehicle manufacture.

Yet there is little doubt that an ugly situation is developing, which could lose the Government much of the workers' support it has had so far in its handling of the Suez crisis. Prices may rise, and make the wage demands all the harder to resist. The most relevant facts to bear in mind are perhaps those mentioned by Mr. Macarty, director of the Engineering and Allied Employers' National Federation: the United Kingdom's share of world export markets for motor vehicles has fallen from 43 per cent. to 28½ per cent. in 3 years; Germany has replaced Britain as the leading exporter of bicycles; manufacturers of farm machinery, Diesel engines, boilers, gas-holders and other engineering products are losing export orders on price. Much may be due to causes other than high wages, but higher wages cannot fail to make matters worse. There could be no worse time for major disputes.

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The Guaranteed Wage

Security of employment is becoming a very live issue in British industry. There is a spontaneous backing by the rank and file for unions' demands in that direction greater, perhaps, and certainly more fervent than even for wage demands. Some employers, among them leading companies, support it and argue strongly that such security is good for the company. But many more look upon the unions' demands with suspicion, or open hostility. For those men, industry's management problems will never be solved until "healthy unemployment" is with us again, and each vacancy has a queue of applicants. Although there is the depth of feeling that will in time lead to guaranteed annual wages, the extent of the security offered to most at present is a guaranteed weekly wage.

The Ministry of Labour *Gazette* publish in this month's issue a survey of guaranteed weekly wage arrangements in industry. The principal industries in which a full normal week's wages—normally at time rates—is guaranteed are agriculture, coal mining, heavy chemicals and plastics, railway service, road passenger transport, road haulage, retail distribution, brewing and film production. General engineering, iron and steel and most metal manufacturing industries, building and civil engineering guarantee four days' pay, or from 32 to 34 hours. Others guarantee a percentage of average weekly earning, excluding overtime, over a previous period. Some guarantee nothing. The general picture is that most British employers are prepared to pay people on their books something approaching their week's wages even if they have no work to do during that time. It is limited security since employers can sack redundant workers without further liability. In practice many workers do better than that, but industry has considerable way to go before the concept of security of employment is generally accepted.

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Holidays for All

A new non-profit organisation has been founded to encourage and assist people to save for holidays and to guide them on when and where to go. There are three main objects: first to enable the 11 million families who stay-at-home each year to have the benefit of a holiday at reasonable cost; second to extend the annual holiday season, and so enable hoteliers to improve standards and facilities and to reduce holiday charges; finally, to remove the casualisation of employment in the catering industry. To achieve these aims, means will have to be found (*a*) to collect weekly or monthly "holiday savings," (*b*) to provide a classified list of "approved" catering establishments, implying the adoption of certain standards and the setting up of an inspectorate and (*c*) to make all necessary arrangements for the booking of accommodation and the settlement of bills.

This is an ambitious scheme but it could sweep the country, as is often the case where things can be paid for gradually and no thinking on the part of the people concerned is involved. The Council for Holidays in Britain will be financed initially mainly by subscriptions from employers, trade unions and catering establishments. These will range from 10*s*. to £100 a year according to size. Individuals can become members for a 5*s*. subscription but the scheme is open to all employees or members of subscribing firms or unions.

Mr. Maurice Orbach, M.P., and Mr. Henry Knight, two of the directors (unpaid) of the Council, hoped that the Council's activities might set new standards in British hostelry and so increase the flow of overseas visitors to this country. The idea is a bold one, and essentially practical.

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